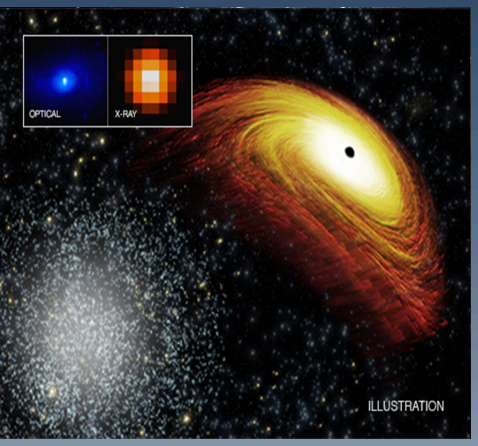
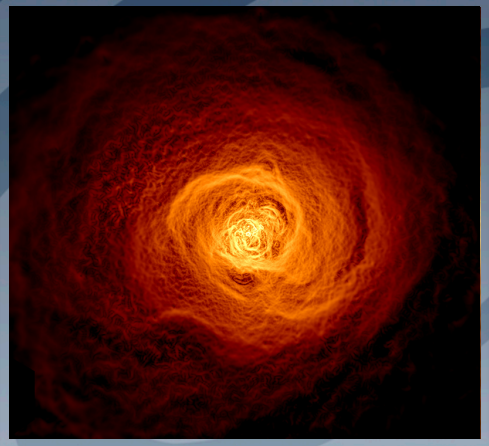
National Aeronautics and Space Administration

Astrophysics




NASA Astrophysics Update

Astrophysics Advisory Committee
July 19, 2017

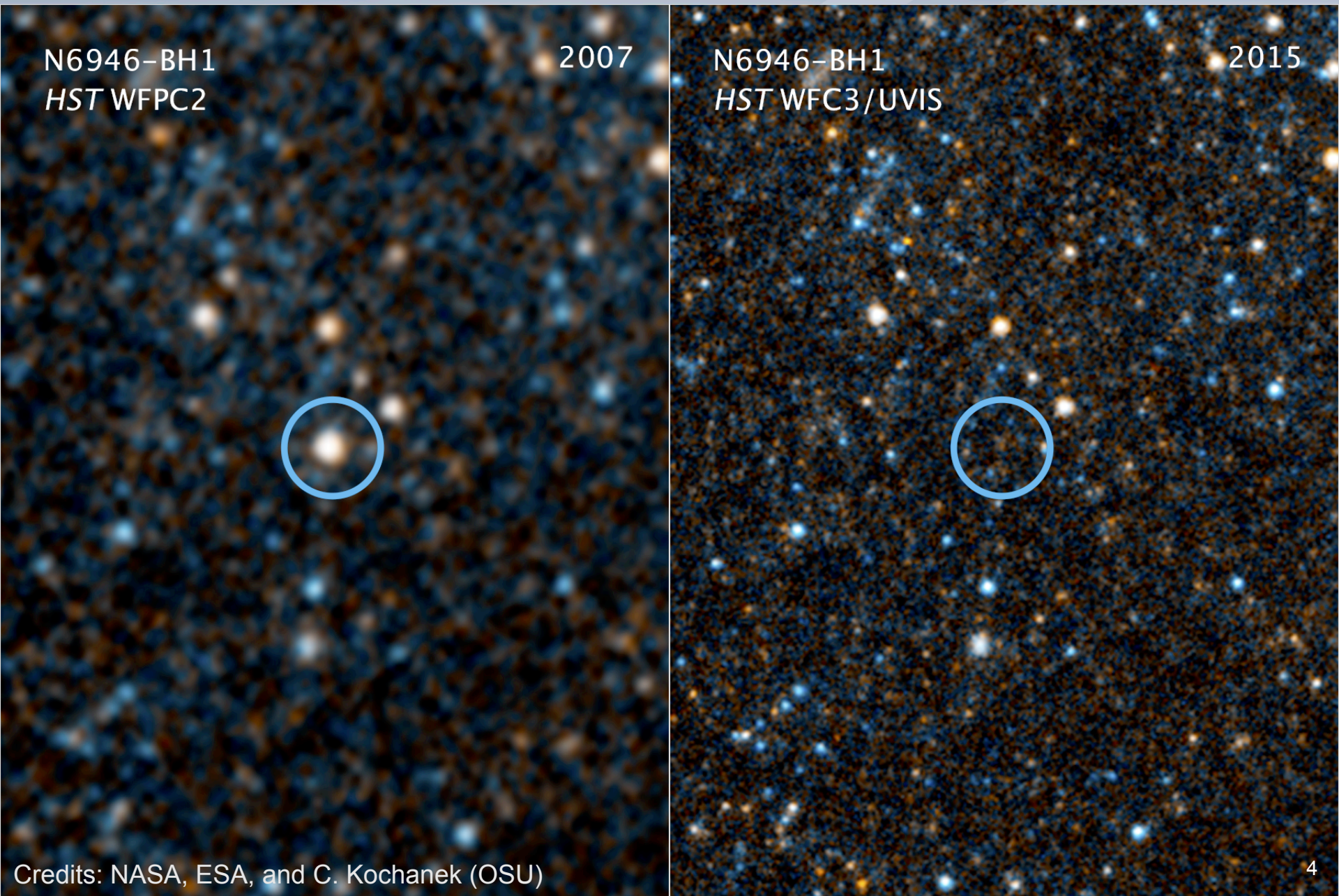
Paul Hertz
Director, Astrophysics Division
Science Mission Directorate
@PHertzNASA

Outline

NASA Astrophysics

Science Highlights

Collapsing Star Gives Birth to a Black Hole



Credits: NASA, ESA, and C. Kochanek (OSU)

Recent Kepler Discovery

Small Planets Come in Two Sizes

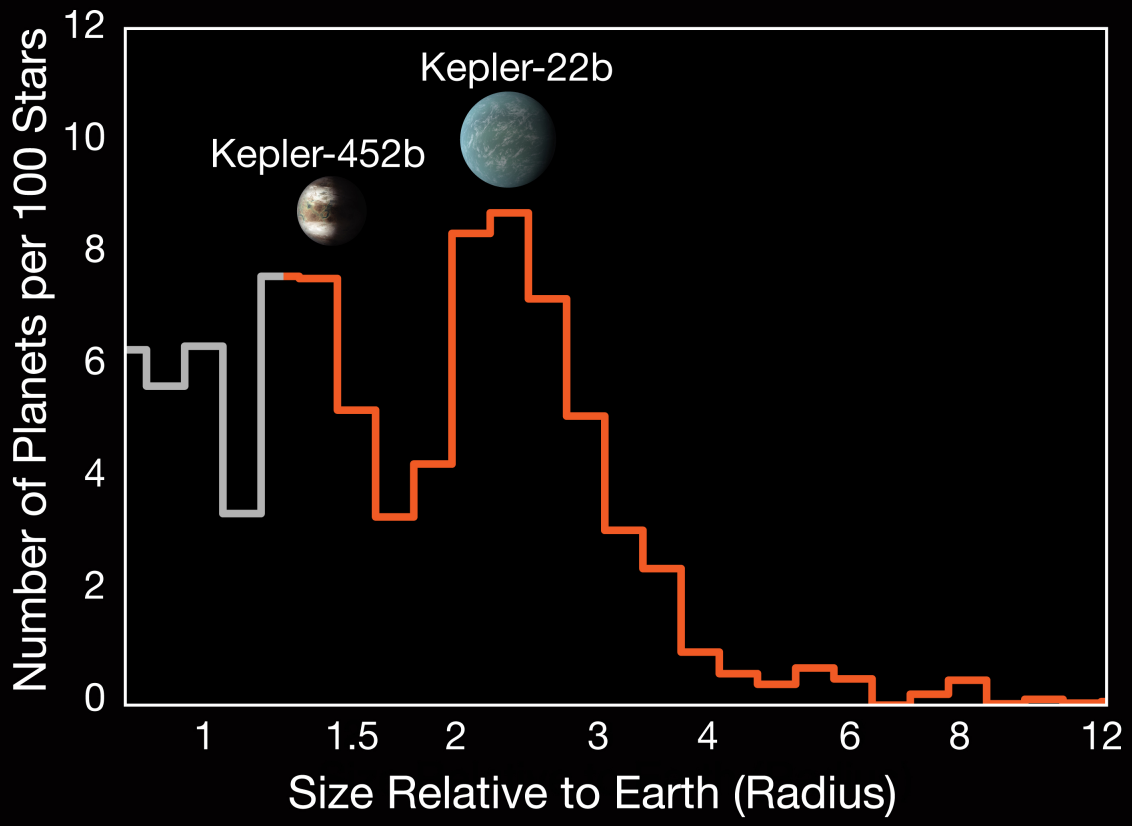


Image credit: NASA/Ames Research Center/Caltech/University of Hawaii/B.J. Fulton

Recent Kepler Discovery

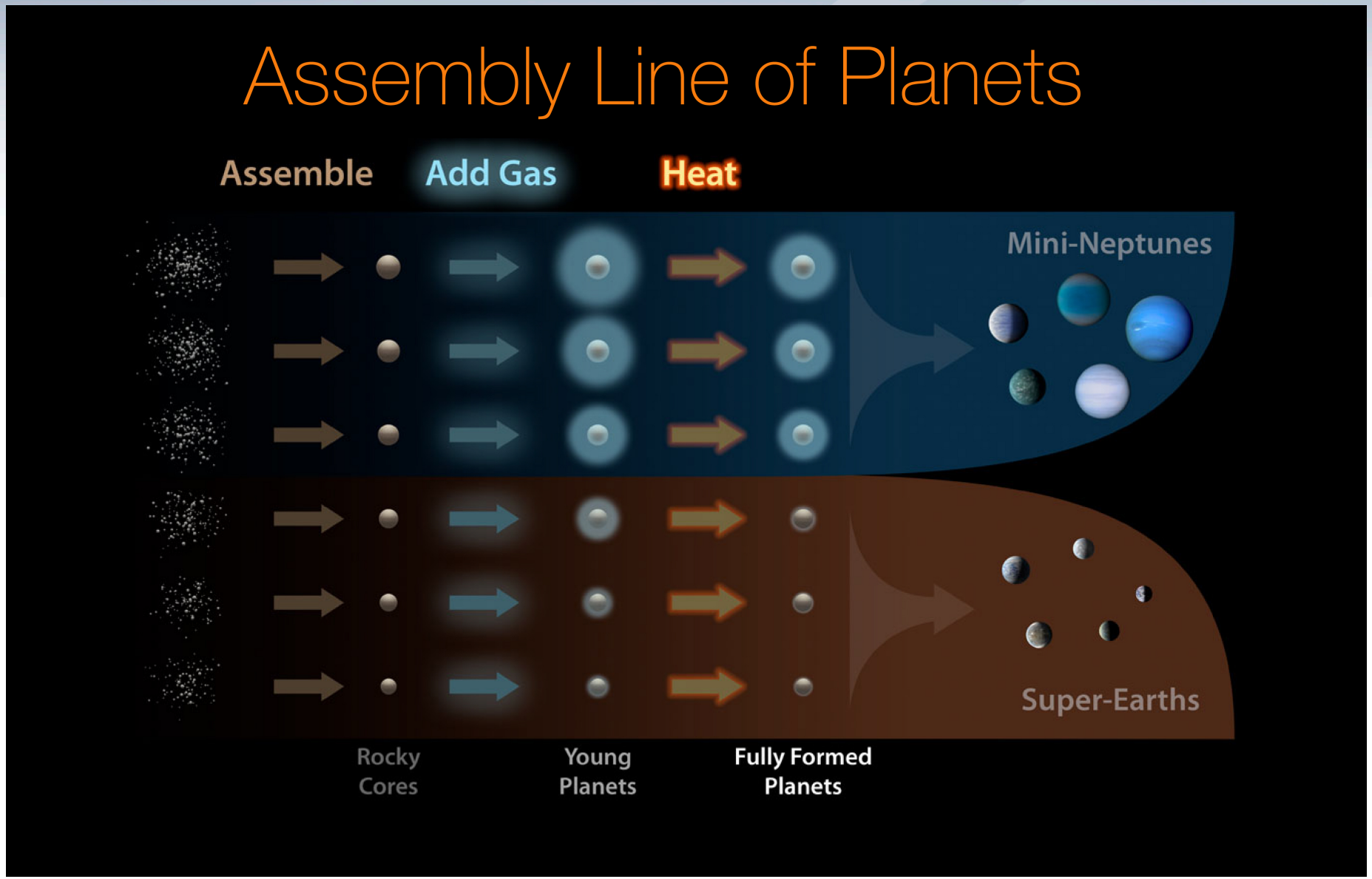
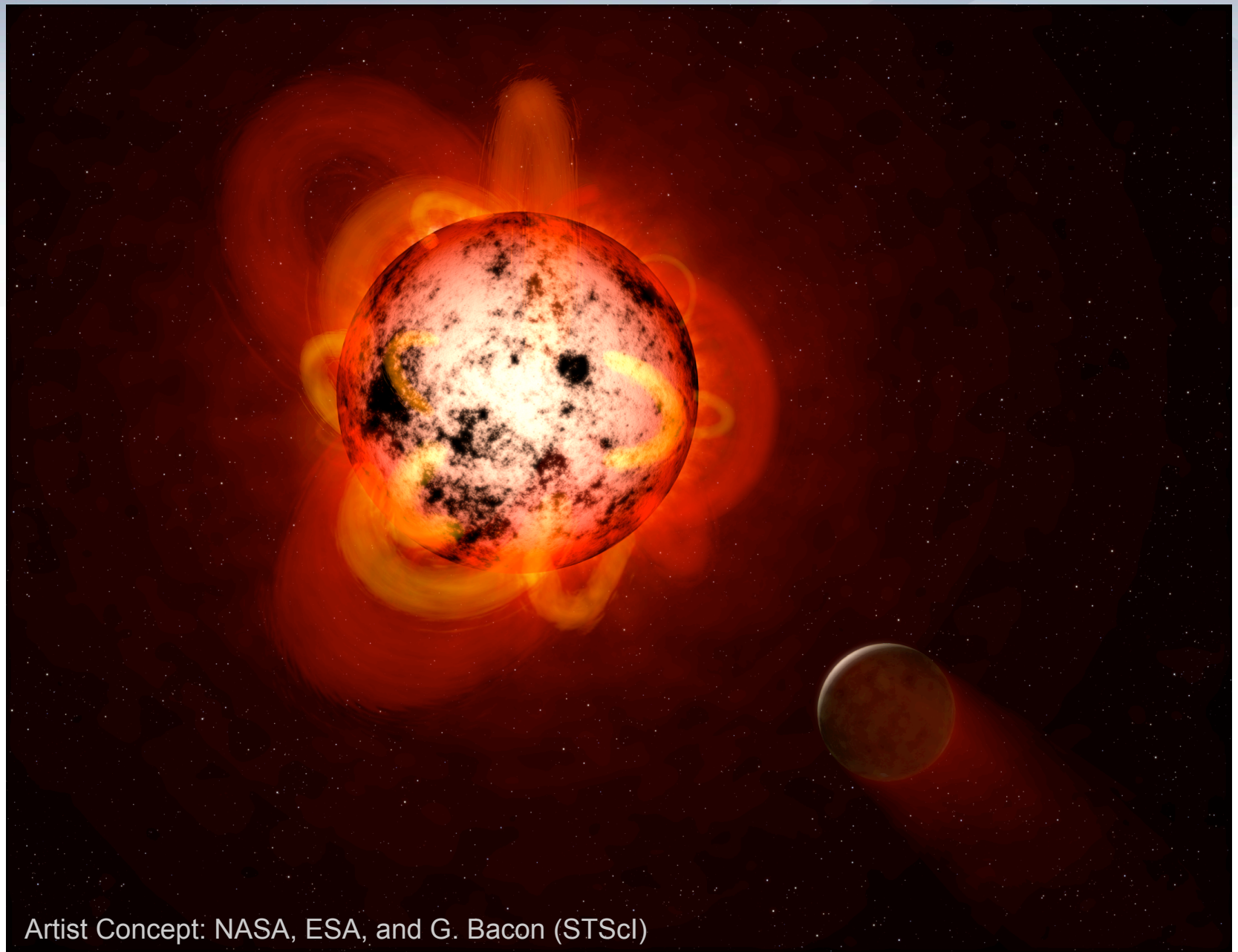


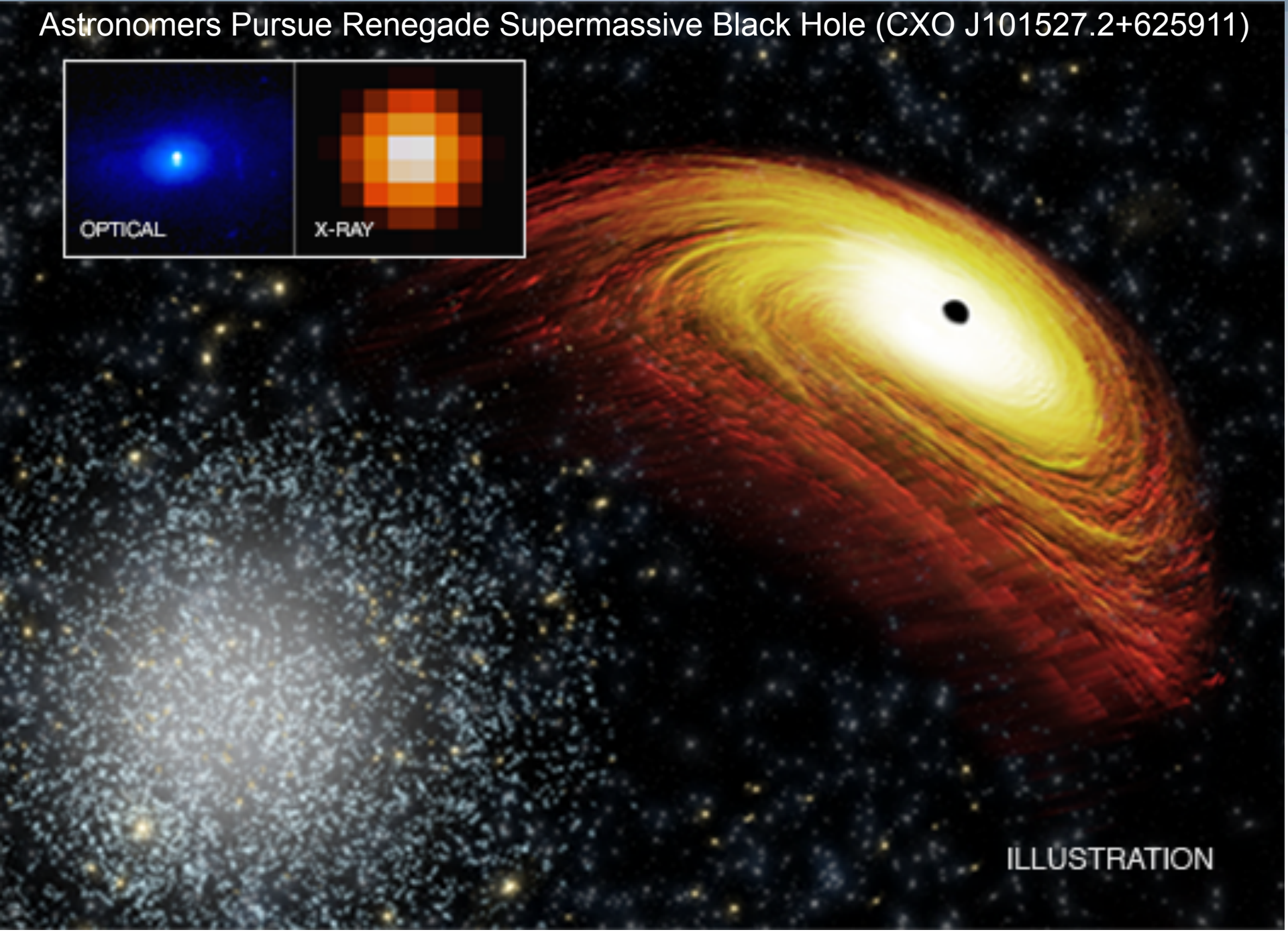
Image credit: NASA/Ames Research Center/JPL-Caltech/R. Hurt

Flaring Red Dwarf Star



Artist Concept: NASA, ESA, and G. Bacon (STScI)

Astronomers Pursue Renegade Supermassive Black Hole (CXO J101527.2+625911)



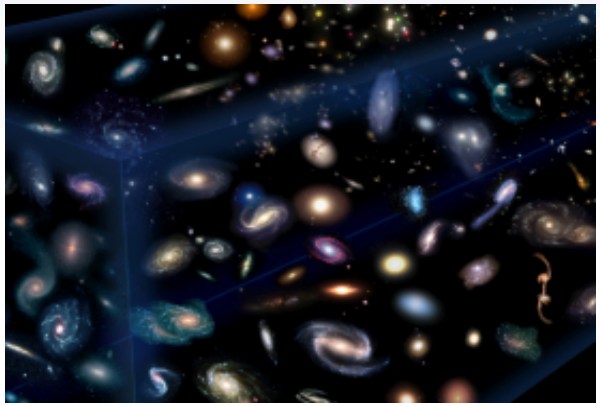
Credit: X-ray: NASA/CXC/NRAO/D.-C.Kim; Optical: NASA/STScI; Illustration: NASA/CXC/M.Weiss

NASA Astrophysics

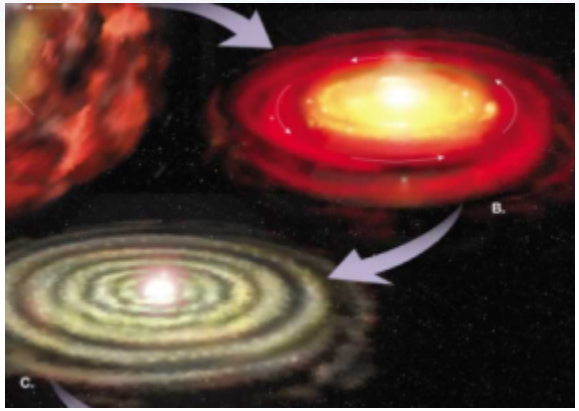
Big Picture (including budget)

Why Astrophysics?

Astrophysics is humankind's scientific endeavor to understand the universe and our place in it.



1. How did our universe begin and evolve?

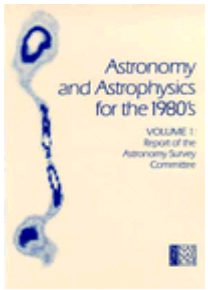


2. How did galaxies, stars, and planets come to be?

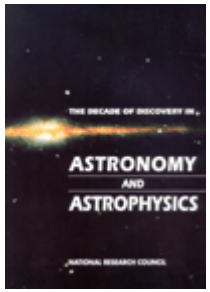
3. Are We Alone?

These national strategic drivers are enduring

1972

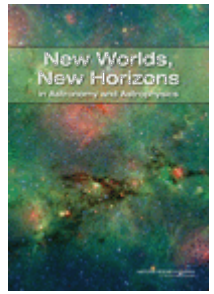


1982



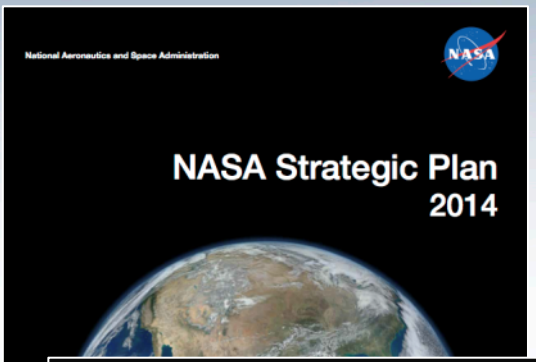
1991

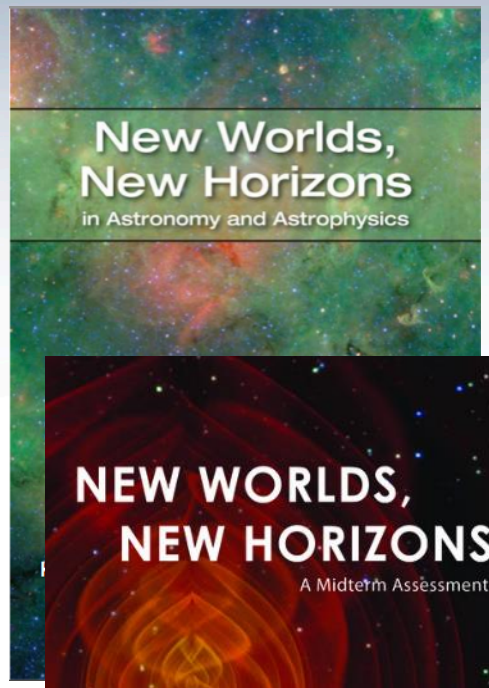
2001

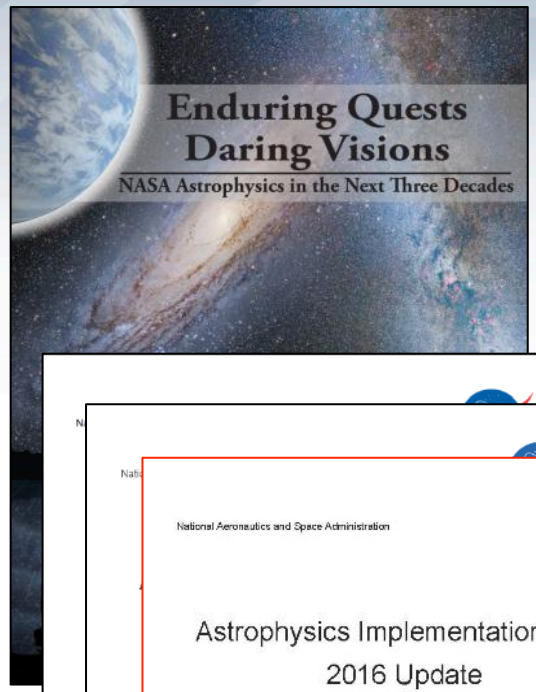


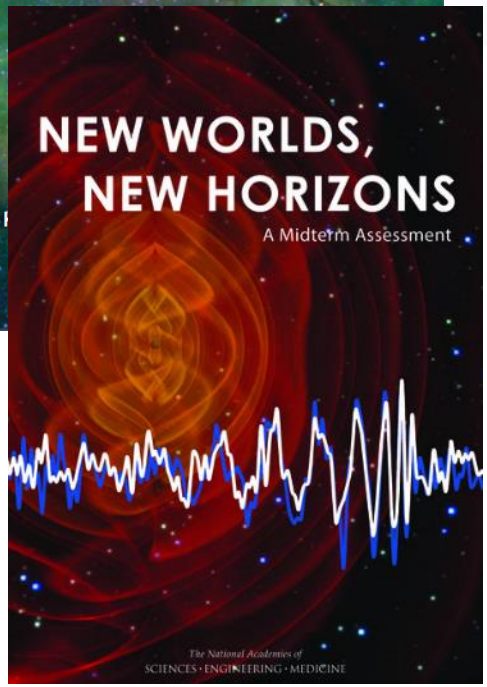
2010

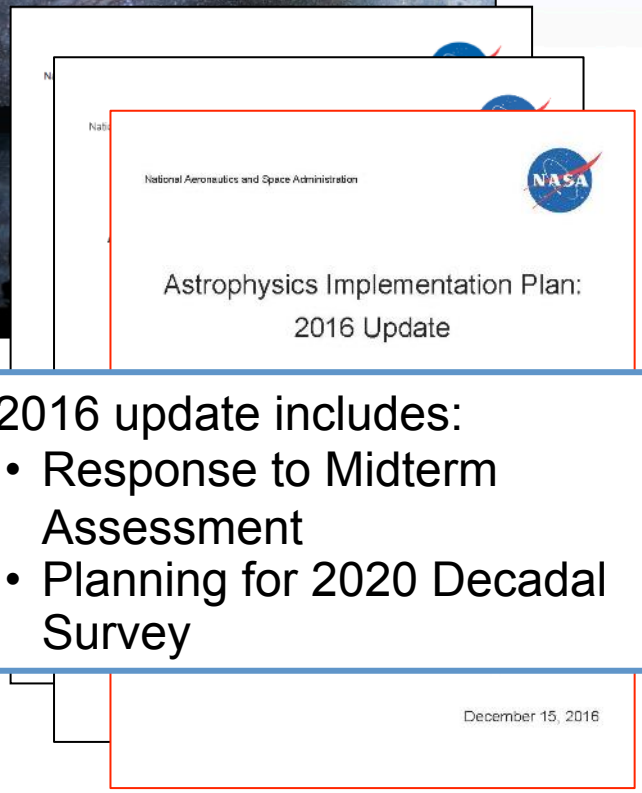
Astrophysics Driving Documents











2016 update includes:

- Response to Midterm Assessment
- Planning for 2020 Decadal Survey

http://science.nasa.gov/astrophysics/documents

Astrophysics - Big Picture (1 of 2)

- **The FY17 appropriation and FY18 budget request provide funding for NASA astrophysics to continue its planned programs, missions, projects, research, and technology.**
  - Total funding (Astrophysics including Webb) remains at ~$1.35B.
  - Funds Webb for an October 2018 launch, WFIRST formulation, Explorers mission development, increased funding for R&A, new suborbital capabilities, continued technology development.
  - FY17 Consolidated Appropriation is less than planning budget; reductions to plans are required.
  - FY18 President's Budget Request balances current science and future missions.
- **NASA continues to prioritize implementation of the recommendations of the 2010 Decadal Survey.**
  - National Academies' 2016 Midterm Assessment Report validates NASA's progress.
  - NASA is conducting large and medium mission concept studies for 2020 Decadal Survey.

Astrophysics - Big Picture (2 of 2)

- **The operating missions continue to generate important and compelling science results, and new missions are under development for the future.**
  - Senior Review in Spring 2016 recommended continued operation of all missions (Chandra, Fermi, Hubble, Kepler, NuSTAR, Spitzer, Swift, XMM); next Senior Review in 2019.
  - SOFIA is adding new instruments: HAWC+ instrument commissioned; HIRMES instrument in development; next gen instrument call planned.
  - ISS-NICER launched on June 3, 2017.
  - NASA missions under development making progress toward launches: ISS-CREAM (August 2017), TESS (2018), Webb (2018), IXPE (2020), GUSTO (2021), WFIRST (mid-2020s).
  - Independent WFIRST technical/management/cost review underway.
  - Partnerships with ESA and JAXA on future missions create additional science opportunities: Euclid (ESA; 2020), XARM (JAXA; 2021), Athena (ESA; 2028), LISA (ESA; 2034).
  - Explorer AOs are being released every 2-3 years: MIDEX/MO proposals received in December 2016, IXPE downselected in January 2017, GUSTO downselected in March 2017, MIDEX/MO selections in Summer 2017, next SMEX/MO AO in 2019.

APAC Requests & Recommendations

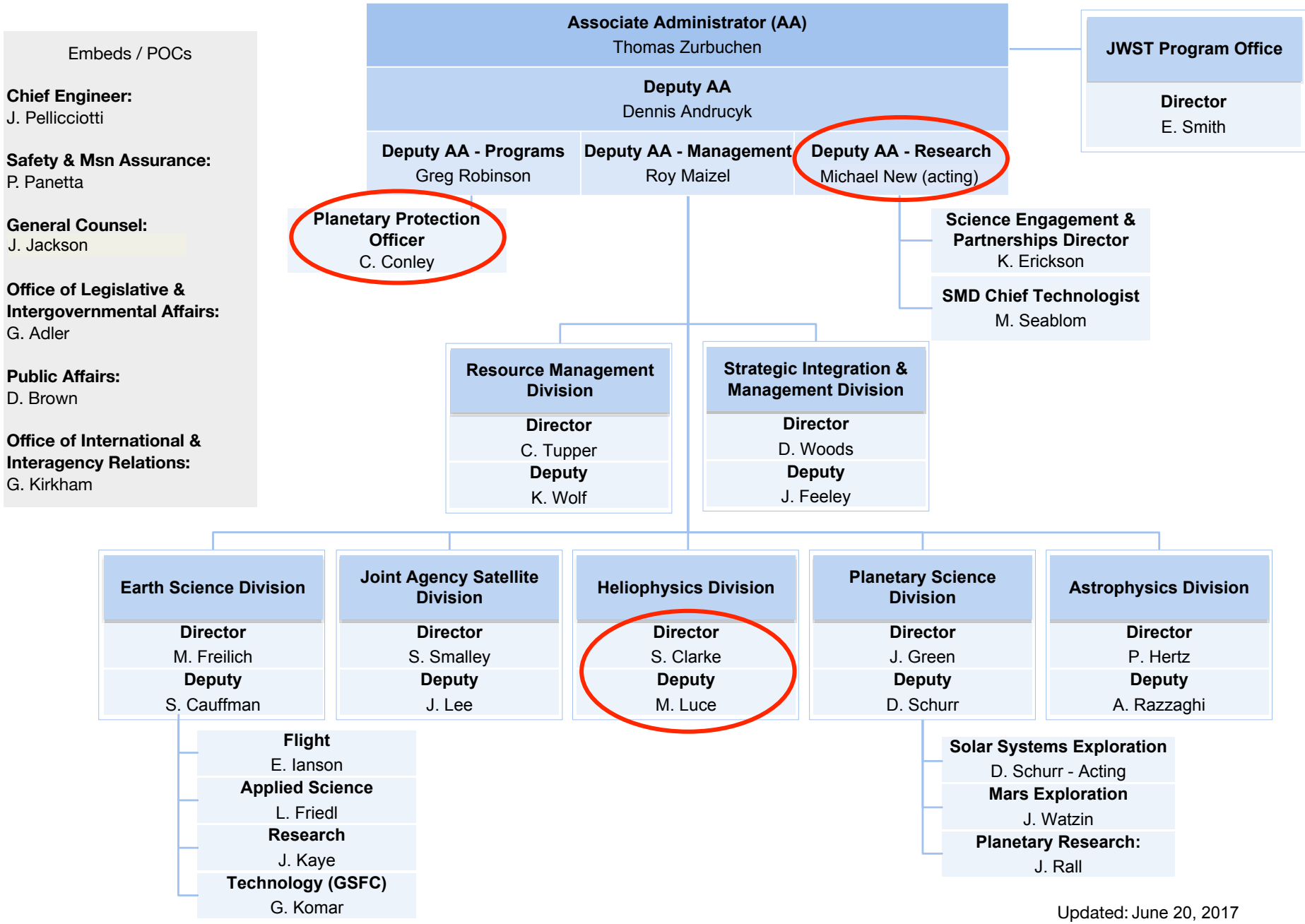
April 2017		
1	The APAC was concerned about the change in the funding model of civil servants and so requests more information about the details of the implementation of this change.	Presentation by Paul Hertz at July 2017 APAC meeting.
2	The APAC requests complete statistics to properly compare the science publication rate and proposal submission and acceptance rates of SOFIA to other major APD Missions. In particular, the APAC would like to see proposal pressure by broken down by instrument and by science discipline.	Report by William Reach and Kimberly Ennico Smith submitted to APAC prior to July 2017 APAC meeting.
3	For the next suborbital report, the APAC would like to hear more about the science, and how the technology developed from that program flows into the large missions, with examples. The APAC would also like to hear how the awards line up with technology gaps.	Presentation by Michael Garcia et al at July 2017 APAC meeting.
4	The APAC recommends that SMD initiate an SMD-wide workshop to connect cubesat capabilities with the broader science community, which would focus on what science the rapidly developing cubesat technologies might enable.	Recommendation presented to Michael Seablom, SMD Chief Technologist, for consideration. Response on next page.
5	The APAC recommends that the PAGs consider highly qualified early career stage scientists as EC members, without increasing the size of the EC significantly.	Accepted. The Astrophysics Division, Program Chief Scientists, and PAG EC Chairs will consider highly qualified early career stage scientists for the next round of EC member appointments.

APAC Requests & Recommendations

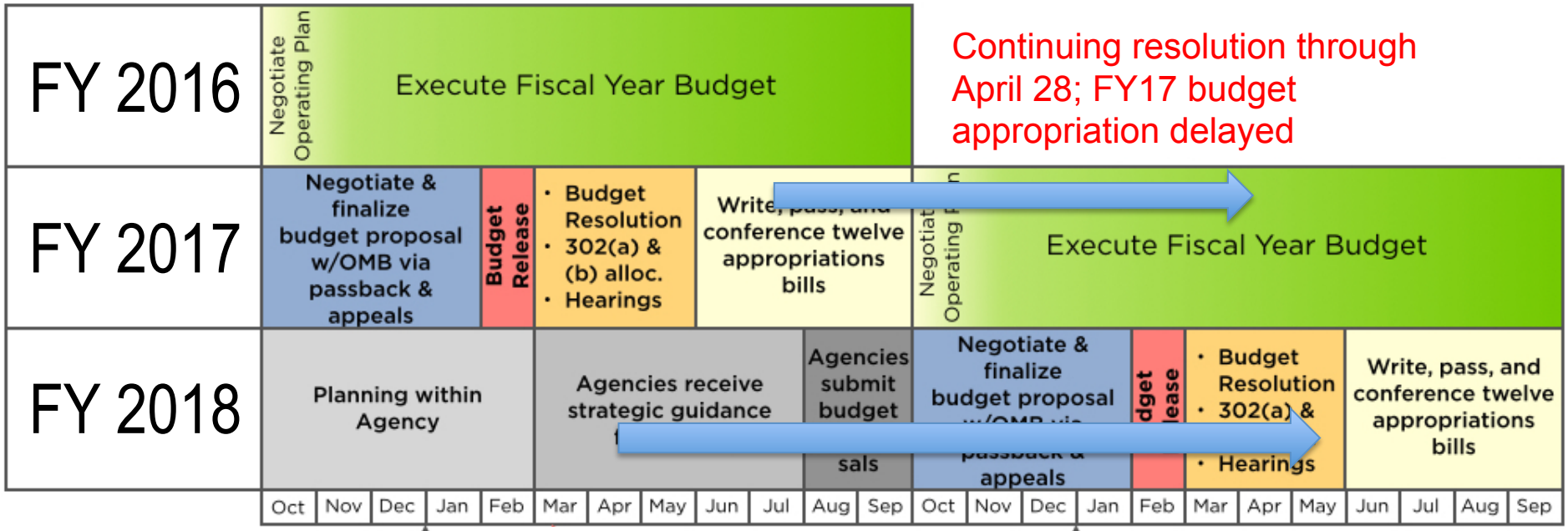
April 2017		
3	For the next suborbital report, the APAC would like to hear more about the science, and how the technology developed from that program flows into the large missions, with examples. The APAC would also like to hear how the awards line up with technology gaps.	SMD is in the process of conducting studies to better understand small satellite / cubesat mission concepts and to subsequently determine where there are unsatisfied technology needs. Through this process, instrument technology gaps and platform technology gaps are now being identified and addressed by SMD and STMD, respectively. SMD has conducted a limited number of science missions with small sats and cubesats, and there have been valuable lessons learned which are being archived by the new Small Spacecraft Systems Virtual Institute (S3VI, see https://www.nasa.gov/smallsat-institute) at NASA Ames. SMD is committed to making small satellite platforms as useful as possible for science missions by setting aside $70 million annually for investments in cubesat instrument technology and for new missions, including $5 million annually in the Astrophysics Division. An SMD-sponsored workshop would bring together the outcomes of the technology studies, the lessons-learned from the teams that have flown missions over the past few years, an overview of the S3VI services, and a discussion of the technology investments made by SMD and STMD to date. The goals of the workshop would be to (a) help the broader scientific community better understand the progress being made by the cubesat community, and (b) to help them understand the resources available to facilitate current and future cubesat missions.

Other Topics from APAC

- Status of Spitzer EOM planning
  - JPL is developing a closeout plan
  - Although the NASA funded mission will end in FY19 per the decisions following the 2016 Senior Review, NASA is open to potential partnering opportunities that allow Spitzer to be operated with non-NASA funding (similar to the final year of the GALAEX mission, which was conducted with funding coordinated by Caltech)
- Status of NAS studies on Exoplanets and Astrobiology
  - These studies are required from NASA by the NASA Transition Authorization Act of 2017
  - NASA has requested the studies from the NAS Space Studies Board, approved the Statements of Work, and provided the funding
  - The NAS has begun the process of populating the committees
  - No Chairs, members, or meetings have been announced by the NAS
- Status of establishing large mission STDTs as subordinate groups to the APAC
  - Higher priority FACA-related actions have been prioritized by SMD, OIIR, and OGC including establishing all four Science Advisory Committees, establishing the Senior Reviews as subordinate groups in Earth Science and Heliophysics, and refreshing the membership of the NAC Science Committee
  - SMD, OGC, and OIIR anticipate beginning the process of re-establishing the Astrophysics STDTs by the end of CY17


Embeds / POCs
Chief Engineer:
J. Pellicciotti
Safety & Msn Assurance:
P. Panetta
General Counsel:
J. Jackson
Office of Legislative & Intergovernmental Affairs:
G. Adler
Public Affairs:
D. Brown
Office of International & Interagency Relations:
G. Kirkham
Associate Administrator (AA)
Thomas Zurbuchen
Deputy AA
Dennis Andrucyk
JWST Program Office
Director
E. Smith
Deputy AA - Programs
Greg Robinson
Deputy AA - Management
Roy Maizel
Deputy AA - Research
Michael New (acting)
Planetary Protection Officer
C. Conley
Science Engagement & Partnerships Director
K. Erickson
SMD Chief Technologist
M. Seablom
Resource Management Division
Director
C. Tupper
Deputy
K. Wolf
Strategic Integration & Management Division
Director
D. Woods
Deputy
J. Feeley
Earth Science Division
Director
M. Freilich
Deputy
S. Cauffman
Joint Agency Satellite Division
Director
S. Smalley
Deputy
J. Lee
Heliophysics Division
Director
S. Clarke
Deputy
M. Luce
Planetary Science Division
Director
J. Green
Deputy
D. Schurr
Astrophysics Division
Director
P. Hertz
Deputy
A. Razzaghi
Flight
E. Ianson
Applied Science
L. Friedl
Research
J. Kaye
Technology (GSFC)
G. Komar
Solar Systems Exploration
D. Schurr - Acting
Mars Exploration
J. Watzin
Planetary Research:
J. Rall
Updated: June 20, 2017

Federal Budget Cycle



Continuing resolution through April 28; FY17 budget appropriation delayed

FY18 budget formulation delayed

Start of Calendar Year 2016

Skipped (which is normal for an Administration change)

Start of Calendar Year 2017

Adapted by Kevin Marvel (AAS)
https://aas.org/files/budgetprocess_adaptedfromaaas.jpg
from budget presentation by Matt Hourihan (AAAS)
http://www.aaas.org/page/presentations

FY17 Consolidated Appropriations Bill (H.R. 244)

	FY 2017 Request	FY 2017 Omnibus Conference	Change from FY2016 Enacted	Change from FY2017 Request
NASA TOTAL	19,025.1	19,653.3	368.3	628.2
Science	5,600.5	5,764.9	175.5	164.4
Earth Science	2,032.2	1,921.0	0.0	-111.2
Planetary	1,518.7	1,846.0	215.0	327.3
Europa	49.6	275.0	100.0	225.4
Astrophysics	781.5	750.0	-17.6	-31.5
STEM Activation[1]	25.0	37.0	0.0	12.0
JWST	569.4	569.4	-50.6	0.0
Heliophysics	698.7	678.5	28.7	-20.2

Note 1: $37.0M for STEM Activation is to be derived equally from Planetary Science and Astrophysics, and continue to be administered by Astrophysics.

FY17 Consolidated Appropriations Bill (H.R. 244)

- The FY17 Appropriation for Astrophysics resulted in a reduction of $63.0M for Astrophysics (including Webb) relative to the FY16 funding level.

$M	FY16 Actual	FY17 Request	FY17 Approp	
Webb	620.0	569.4	569.4	Planned decrease of $50.6M
Astrophysics	762.4	781.5	750.0	Down $31.5M from FY17 request
Astrophysics w/ Webb	1,382.4	1,350.9	1,319.4	Down $63.0M from FY16 actual

- The FY17 Appropriation for Astrophysics resulted in a reduction of $31.5M for Astrophysics (including Webb) relative to the FY17 budget request.
- The FY17 Appropriation for Astrophysics resulted in a reduction of up to $47.4M for Astrophysics programs excluding Webb, Hubble, SOFIA, WFIRST, relative to the FY17 budget request.

FY17 Consolidated Appropriations Bill (H.R. 244)

	FY17 Request	FY17 Approp	Language from Conference Committee Report
Total	1,350.9	1,319.0	
Webb	569.4	569.4	Includes $569.4M for Webb
WFIRST	90.0	105.0	Includes $105M for WFIRST; Committee directs NASA to cap WFIRST life cycle costs at no more than $3,500M through the end of its prime mission
SOFIA	83.8	85.2	Provides $85.2M for SOFIA
Hubble	97.3	98.3	Provides $98.3M for Hubble Space Telescope
Mirror Tech	-	5.0	Includes up to $5M for segmented aperture telescope activities
Starshade	-	-	Supports continued appropriate technology development for a starshade
STEM Activation	25.0	18.5	Includes $37M for STEM Activation programs, derived from Planetary Science and Astrophysics
Rest of Astrophysics	485.4	438.0	

- Up to $47.4M reduction to “Rest of Astrophysics” (Astrophysics excluding Webb, WFIRST, SOFIA, Hubble) relative to FY17 request; 11% reduction with 4 months remaining in FY17

FY18 President's Budget Request

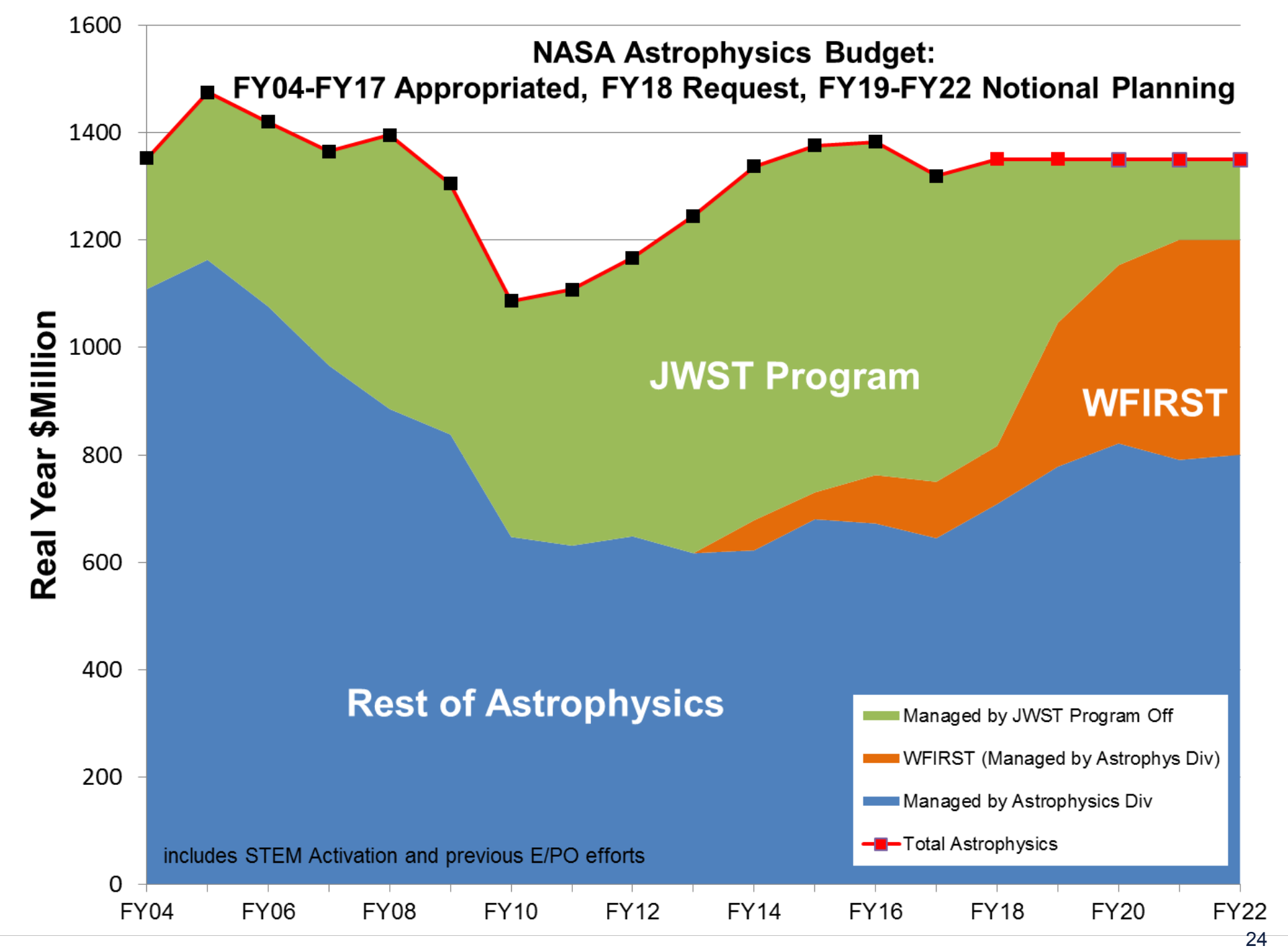
$M	FY16 Actual	FY17 Omnibus	FY18 Request	Change from FY16	Change from FY17
NASA	19,285	19,653	19,092	-1.0 %	-2.9%
SMD	5,584	5,765	5,712	+2.3 %	-0.9 %
Earth Science	1,927	1,921	1,754	-9.0 %	-8.7 %
Heliophysics	647	679	678	+4.8 %	-0.1 %
Planetary Science	1,628	1,846	1,930	+18.6 %	+4.6 %
Astrophysics (including Webb)	1,382	1,319	1,350	-2.3%	+1.6 %

- Maintains commitment to studying our home planet and the universe
- Enables our wide ranging science work on many fronts, which continues to lead the world in its size, scope, and scientific output.
- Reinvigorates robotic exploration of the solar system, including funding for a Europa Clipper mission to fly repeatedly by Jupiter's icy ocean moon Europa.
- Maintains a robust Earth Science program while terminating several missions.
- Supports initiatives that use smaller, less expensive satellites and/or public-private partnerships to advance science, in keeping with recent National Academies recommendations.

FY18 President's Budget Request

	Actual	Enacted	Request	Notional			
Budget (in $ millions)	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Astrophysics Research	193	--	204	221	225	262	288
Cosmic Origins	196	--	192	190	142	158	156
Physics of the Cosmos	125	--	100	109	111	94	94
Exoplanet Exploration	141	--	176	351	473	476	440
Astrophysics Explorer	108	--	145	175	201	212	222
James Webb Telescope	620	569	534	305	197	150	150
Total Astrophysics	1382	1319	1350	1350	1350	1350	1350

- Supports an SMD-wide CubeSat/SmallSat initiative that uses smaller, less expensive satellites to advance science in a cost-effective manner.
- Reflects more efficient operations of the Hubble Space Telescope, without impact to science.
- Reflects efficiencies realized by the SOFIA in the past few years. SOFIA will participate in the 2019 Astrophysics Senior Review.


NASA Astrophysics Budget:
FY04-FY17 Appropriated, FY18 Request, FY19-FY22 Notional Planning
Real Year $Million
1600
1400
1200
1000
800
600
400
200
0
FY04
FY06
FY08
FY10
FY12
FY14
FY16
FY18
FY20
FY22
JWST Program
WFIRST
Rest of Astrophysics
includes STEM Activation and previous E/PO efforts
Managed by JWST Program Off
WFIRST (Managed by Astrophys Div)
Managed by Astrophysics Div
Total Astrophysics

Responding to the 2010 Decadal Survey
Responding to the Midterm Assessment

Prioritized Recommendation	NASA plans (partial list)
LARGE ACTIVITIES	
WFIRST	In Phase A, launch in mid-2020s, independent technical/management cost review
Explorers	Executing 4 AOs per decade, maintain cadence
LISA	Partnering on ESA's space-based gravitational wave observatory; increased contribution
IXO	Partnering on ESA's Athena x-ray observatory
MEDIUM ACTIVITIES	
Exoplanet technology	WFIRST coronagraph, reductions being considered for starshade and coronagraph technology development beyond the WFIRST coronagraph
Inflation Probe technology	3 balloon-borne technology experiments
SMALL ACTIVITIES	
R&A augmentations	R&A up 20% since FY10; not targeted except TCAN
Mid-TRL technology	Initiated Strategic Astrophysics Technology program; focused on identified missions
Suborbital missions	Initiated super pressure balloon capability

FY18 Budget – House Markup

$M	FY16 Actual	FY17 Omnibus	FY18 Request	FY18 House Markup	Change from Request
NASA	19,285	19,653	19,092	19,871	+4.1%
SMD	5,584	5,765	5,712	5,859	+2.6%
Earth Science	1,927	1,921	1,754	1,704	-2.9%
Heliophysics	647	679	678	678	---
Planetary Science	1,628	1,846	1,930	2,121	+9.9%
Astrophysics (including Webb)	1,382	1,319	1,350	1,356	+0.1%

- Priorities in the decadal surveys shall drive NASA mission priorities.
- NASA [shall] ensure that the United States is the first nation to launch an interstellar mission to the nearest Earth-like planet that shows evidence of extant life.
  - [NASA shall provide], no later than May 2018, a technology assessment report … that includes a draft conceptual roadmap for developing an interstellar propulsion system that will achieve at least .10 of the speed of light, and that will launch no later than July 20, 2069, the 100th anniversary of the Apollo 11 moon landing.

FY18Budget – House Markup

- Astrophysics (including Webb) receives $1,355.7M, an increase of $5.3M over the request
  - Astrophysics R&A receives $74.1M (as requested)
  - Webb receives $533.7M (as requested); NASA shall brief the Committee within 180 days of enactment of this Act regarding the future funding profile of the Astrophysics portfolio as JWST concludes development.
  - SOFIA receives $85.2M (an increase of $5.3M over the request)
    - NASA shall issue a call for fourth generation instrument proposals and select step 1 instrument proposals on or before September 30, 2018.
    - NASA is encouraged to undertake at least 100 SOFIA science mission flights during fiscal year 2018, including both Northern and Southern hemisphere missions, as determined by science community demand through competitively-selected proposals.
    - NASA shall not undertake any actions leading to the premature shutdown of the SOFIA program without the participation of international partners, as appropriate, in any scientific reviews and formulation of recommendations.
    - NASA shall not undertake any changes that would be disruptive to the SOFIA program and the management of its operations.

FY18 Budget – House Markup

- Astrophysics (including Webb) receives $1,355.7M, an increase of $5.3M over the request
  - Astrophysics observatories
    - In anticipation of the forthcoming decadal survey, NASA shall provide a report within 180 days of the enactment of this Act that summarizes NASA's plans for maintaining U.S. leadership in obtaining astrophysical observations in the x-ray and gamma-ray wavelengths following the completion of the Chandra X-ray Observatory and the Fermi Gamma-ray Space Telescope missions.
  - Astrophysics probes
    - NASA shall seek input from the National Academy of Sciences and the academic and scientific community regarding the need for, and benefits of, establishing a competitive, principle investigator-led astrophysics program to bridge the gap between Explorer and less-frequent Flagship missions. NASA shall provide an interim report on these matters within 180 days of enactment of this Act, with a final report to be submitted no later than one year after enactment of this Act.
  - WFIRST receives $126.6M (as requested)
    - The Committee is concerned about potential cost growth in this program and directs NASA to brief it on the results of an independent, external review that NASA initiated in April 2017 to address the scope of WFIRST to ensure it will provide compelling scientific capability with an affordable cost and a reliable schedule.

FY18Budget – House Markup

- Astrophysics (including Webb) receives $1,355.7M, an increase of $5.3M over the request
  - WFIRST receives $126.6M (as requested)
    - Within amounts provided for WFIRST, $20M is for continued development of the Starshade technology demonstration effort. The Committee expects WFIRST to accommodate the Starshade technology demonstration mission. The Starshade, in tandem with WFIRST, will enable NASA to identify the nearest Earth-like planet around the nearest star, and thereby identify a target or multiple targets for the interstellar mission discussed later in this report.
    - The Committee also directs NASA to accelerate work on Starshade and WFIRST to ensure that WFIRST is Starshade compatible, and that Starshade will launch and be capable of working with WFIRST to identify the nearest Earth-like planet that shows evidence of extant life.
    - The Committee directs NASA to include a section in the interstellar propulsion technology report which details NASA's plan to make WFIRST Starshade compatible and what size, design and funding requirements are necessary for Starshade and WFIRST to resolve the planet from the star and spectrographically analyze the atmosphere of rocky Earth-like planets in the habitable zones of stable, long-lived stars out to a distance of 10 parsecs.
    - NASA is encouraged to collaborate with the National Academies of Sciences to create a permanent Decadal Survey for Exoplanet Exploration for the next decade and beyond, and NASA is directed to follow the recommendations of this new Exoplanet Exploration Decadal Survey in developing America's long-term plans for systematic interstellar exploration missions to Earth-like planets harboring life in our galactic neighborhood.

NASA Astrophysics

Research and Analysis Update

Astrophysics Research Elements

Supporting Research and Technology

- Astrophysics Research & Analysis (APRA)
- Strategic Astrophysics Technology (SAT)
- Astrophysics Theory Program (ATP)
- Theoretical and Computational Astrophysics Networks (TCAN)
- Exoplanet Research Program (XRP)
- Roman Technology Fellowships (RTF)

Data Analysis

- Astrophysics Data Analysis (ADAP)
- GO/GI programs in ROSES for:
  - Fermi
  - Kepler/K2
  - Swift
  - NuSTAR
  - TESS (new)

Mission Science and Instrumentation

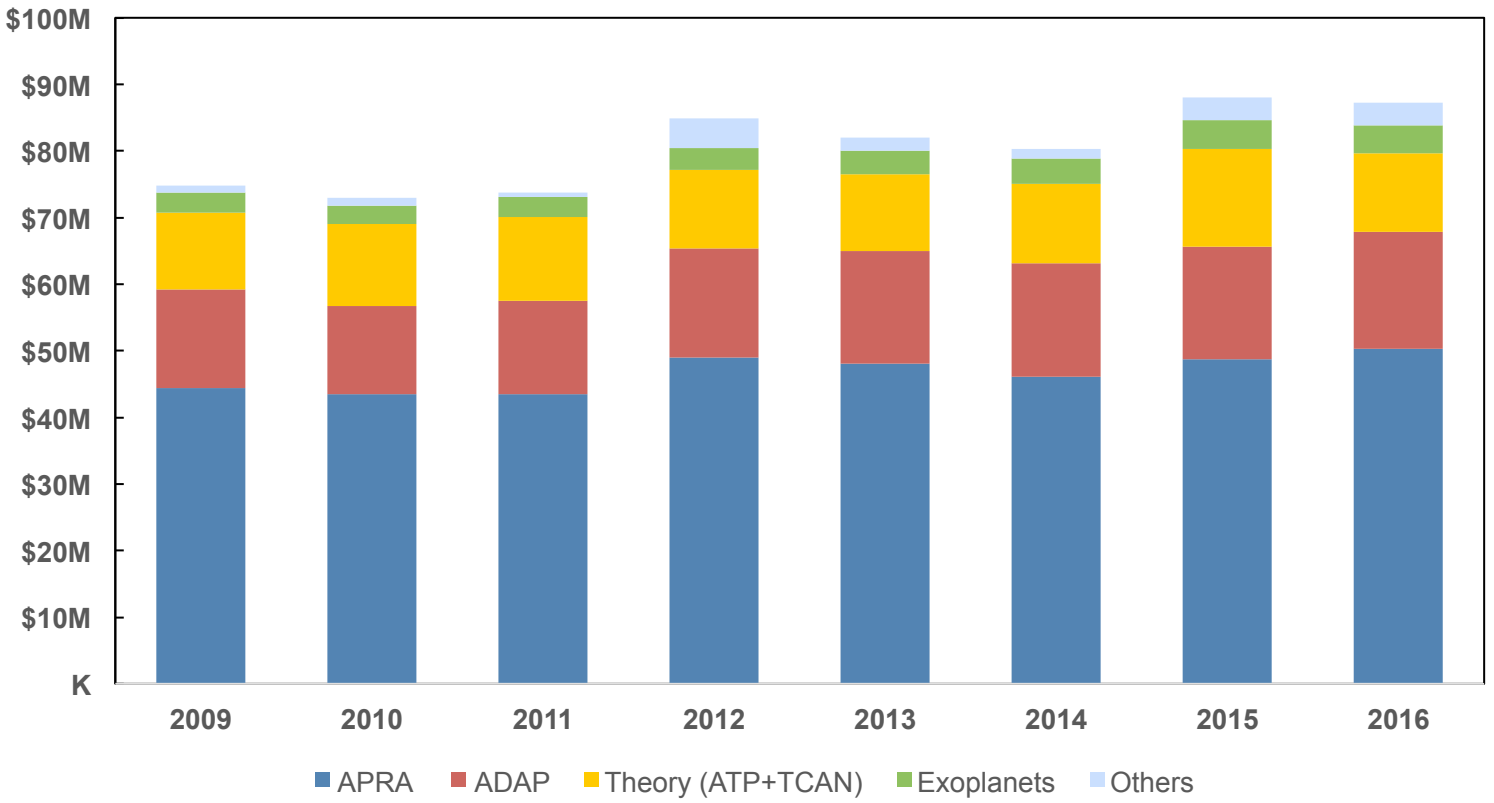
- SOFIA next-generation instrumentation
- Sounding rocket, balloon, cubesat, and ISS payloads through APRA

Separately Solicited

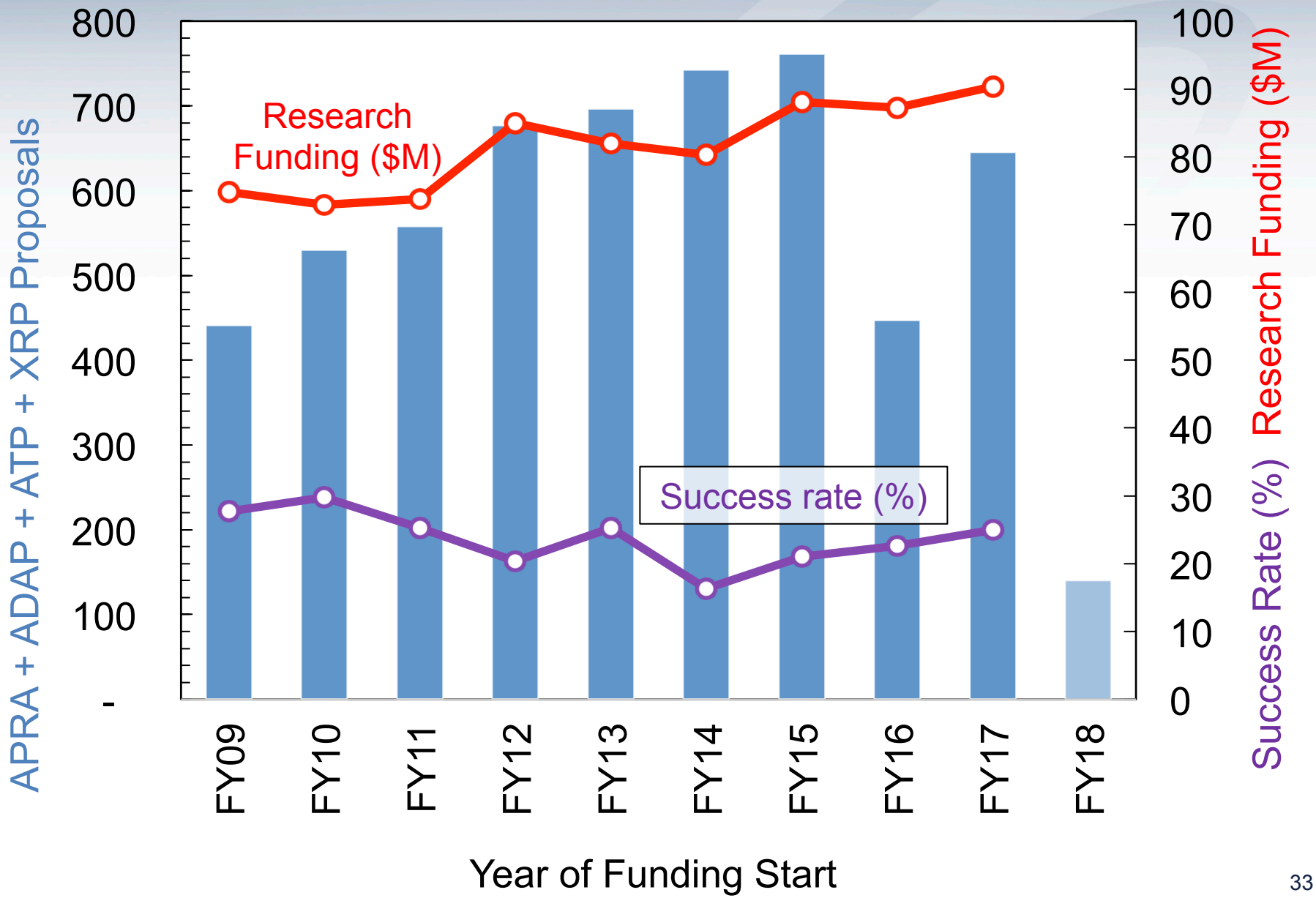
- GO/GI/Archive/Theory programs for:
  - Chandra
  - Hubble
  - SOFIA
  - Spitzer
  - Webb
- Postdoctoral Fellowships (Einstein, Hubble, Sagan)
- Graduate Student Fellowships (NESSF)

Historical R&A Budget Trends

Program	2009	2010	2011	2012	2013	2014	2015	2016
APRA	$44 M	$44 M	$43 M	$49 M	$48 M	$46 M	$49 M	$50 M
ADAP	$15 M	$13 M	$14 M	$16 M	$17 M	$17 M	$17 M	$18 M
Theory (ATP+TCAN)	$11 M	$12 M	$13 M	$12 M	$12 M	$12 M	$15 M	$12 M
Exoplanets (XRP)	$3 M	$3 M	$3 M	$3 M	$4 M	$4 M	$4 M	$4 M
Others	$1 M	$1 M	$1 M	$5 M	$2 M	$1 M	$3 M	$3 M
Total	**$75 M**	**$73 M**	**$74 M**	**$85 M**	**$82 M**	**$80 M**	**$88 M**	**$87 M**



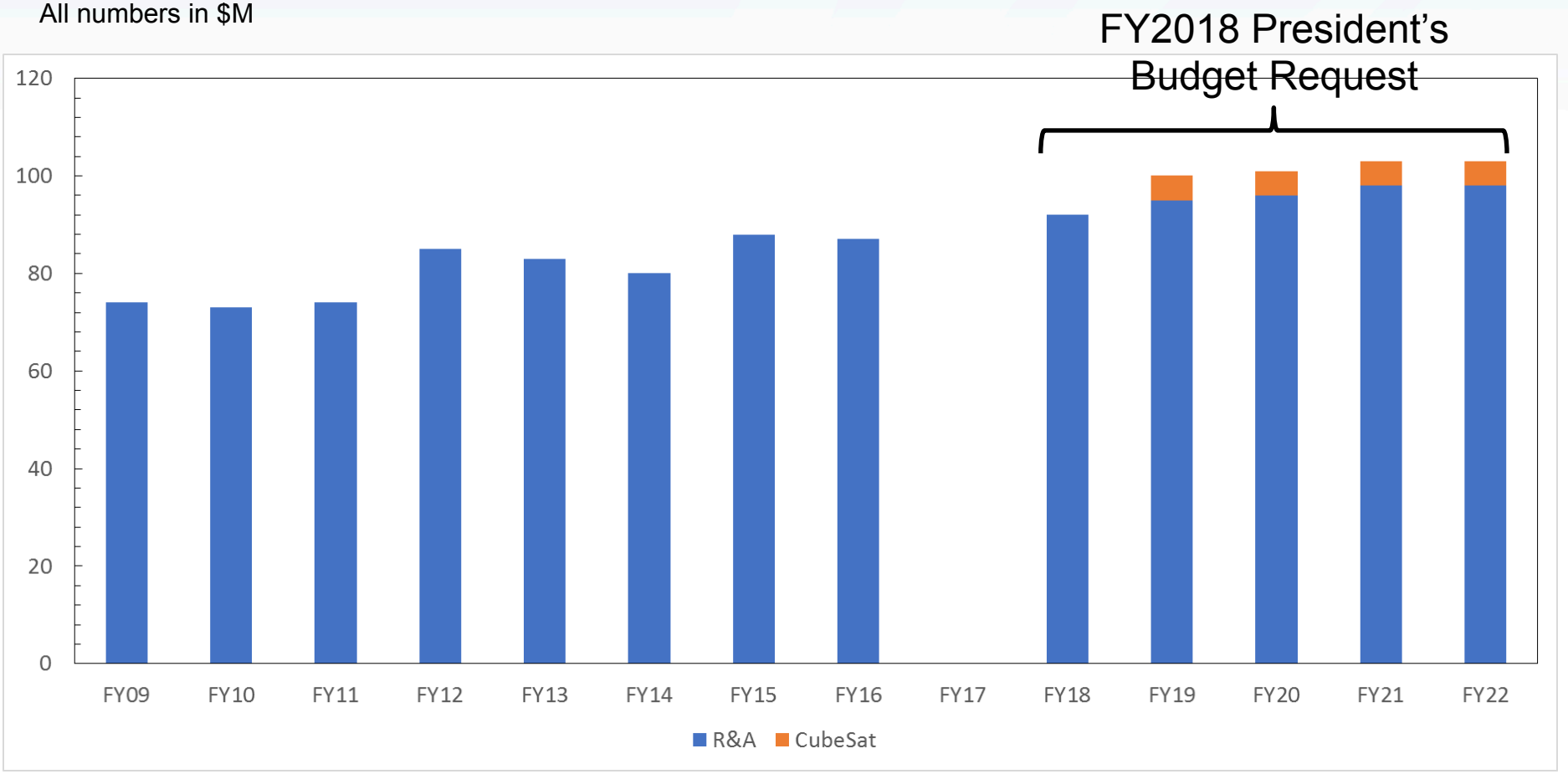
Program Pressure



Proposed Future Budget

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
R&A	$ 75	$ 73	$ 74	$ 85	$ 82	$ 80	$ 88	$ 87		$ 92	$ 95	$ 96	$ 98	$ 98
Cubesat											$ 5	$ 5	$ 5	$ 5
Total	$ 75	$ 73	$ 74	$ 85	$ 82	$ 80	$ 88	$ 87		$ 92	$ 100	$ 101	$ 103	$ 103

All numbers in $M



Recent Proposal Selections

Status: June 21, 2017

	Proposal Due Date	Notify Date	Days past received	Number received	Number selected	% selected
Kepler K2 GO – Cycle 4	Mar 4, 2016	July 11, 2016	118	109	36	33%
Chandra GO – Cycle 18	Mar 15, 2016	July 18, 2016	125	556	168	30%
APRA (Basic Research)	Mar 18, 2016	Aug 13, 2016	148	157	64	41%
SAT (Technology)	Mar 18, 2016	Aug 15, 2016	150	29	7	24%
Hubble GO – Cycle 24	Apr 8, 2016	June 24, 2016	77	1094	245	22%
ADAP (Data Analysis)	May 13, 2016	Sep 22, 2016	132	238	45	19%
Exoplanet Research	May 23, 2016	Oct 7, 2016	134	47	9	19%
Spitzer GO – Cycle 13	June 8, 2016	Aug 5, 2016	58	115	49	43%
SOFIA GI – Cycle 5	July 1, 2016	Oct 25, 2016	116	179	71	40%
Astrophysics Theory	July 8, 2016	Dec 9, 2016	154	201	36	18%
Swift GI – Cycle 13	Sep 23, 2016	Jan 17, 2017	147	155	39	25%
Kepler K2 GO – Cycle 5	Dec 15, 2016	April 4, 2017	110	91	28	31%
NuSTAR GO – Cycle 3	Jan 27, 2017	May 10, 2017	103	217	80	37%
NESSF-17	Feb 1, 2017	June 1, 2017	120	143	8	6%
Fermi GI – Cycle 10	Feb 24, 2017	May 30, 2017	95	183	43	23%
Chandra GO – Cycle 19	Mar 16, 2017		97	574		
Roman Tech Fellowship	Mar 17, 2017		96	12		
SAT (Technology)	Mar 17, 2017		96	30		
APRA (Basic Research)	Mar 17, 2017		96	140		
Hubble GO – Cycle 25	Apr 7, 2017		75	1208		
ADAP (Data Analysis)	May 16, 2017		36	263		

100% of recent announcements within 154 days

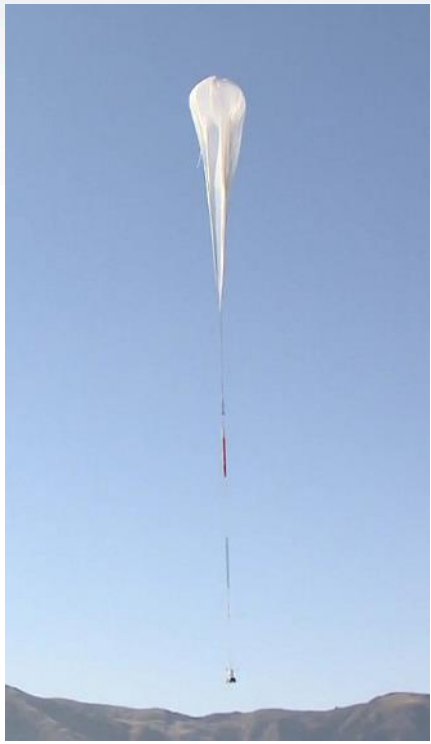
R&A Selection Rate: 23%; GO Selection Rate: 27%

Proposal Opportunities

	Proposal Due Date	Reference
SOFIA Cycle 6	June 30, 2017	www.sofia.usra.edu
Astrophysics Theory Program (ATP)	July 27, 2017	ROSES-17 D.4
Webb Early Release Science	August 18, 2017	jwst.stsci.edu
Keck Observing	September 14, 2017	nexsci.caltech.edu/missions/KSA/
Swift Guest Investigator - Cycle 14	September 21, 2017	ROSES-17 D.5
XMM-Newton - Cycle 17	October 6, 2017	heasarc.gsfc.nasa.gov
K2 Guest Investigator - Cycle 6	Fall 2017 (Step 0); Spring 2018 (Steps 1 and 2)	ROSES-17 D.7
NuSTAR General Observer - Cycle 4	Winter 2017/18	ROSES-16 D.10
Fermi Guest Investigator - Cycle 11	Winter 2017/18	ROSES-16 D.6
NESSF	Approx February 2018	NSPIRES
Webb General Observer Cycle 1	March 2, 2018	jwst.stsci.edu
Chandra General Observer - Cycle 20	Approx March 2018	cxc.harvard.edu
Nancy Grace Roman Technology Fellowship	March 15, 2017	ROSES-16 D.9
Strategic Astrophysics Technology (SAT)	March 15, 2017	ROSES-16 D.8
Astrophysics Research and Analysis (APRA)	March 15, 2017	ROSES-16 D.3
TESS Guest Investigator - Cycle 1	9 months before launch	ROSES-17 D.11
TCAN	Spring 2018	ROSES-17 D.12
SOFIA next-generation instrumentation	TBD	ROSES-17 D.13

2017 Balloon Campaigns

- Completed Spring FY17 Super Pressure Balloon Campaign @ New Zealand
  - ✓ **EUSO (**Extreme Universe Space Observatory on a Super Pressure Balloon) A. Olinto, U of Chicago -
    - **Launched:** April 24 from Wanaka, New Zealand.
    - First experiment to observe individual Ultrahigh Energy Cosmic Rays from top of the atmosphere using air fluorescence.
    - **Flight duration:** 12.2 days: Flight terminated due to (suspected) leak in super pressure balloon. Balloon and payload was dropped into the Pacific Ocean ~255 miles SE of Easter Island.
- Summer FY17 Conventional Balloon Campaign @ Palestine, TX (June 2017).
  - ✓ BETTI (Balloon Experimental Twin Telescope for Infrared Interferometry)/S. Rinehart/GSFC.
  - – Superbit (Balloon-borne Imaging Telescope)/W. Jones/Princeton.
  - – PIPER (Primordial Inflation Polarization Explorer)/A. Kogut/GSFC.
- Fall FY17 Conventional Balloon Campaign @ Fort Sumner, NM
  - – PIPER (Primordial Inflation Polarization Explorer)/A. Kogut/GSFC.
  - – FIREBALL (Faint Intergalactic medium Redshift Emission Balloon)/ C. Martin/Caltech
- Winter FY18 Long Duration Balloon Campaign in Antarctica (December 2017)
  - – Super-TIGER (Super Trans-Iron Galactic Element Recorder)/W. Binns/Wasington U.



EUSO-SPB launch from Wanaka NZ

https://www.nsbf.nasa.gov/index.html

Sounding Rocket Launch

CHESS-3

(Colorado High-resolution Echelle Stellar Spectrograph)

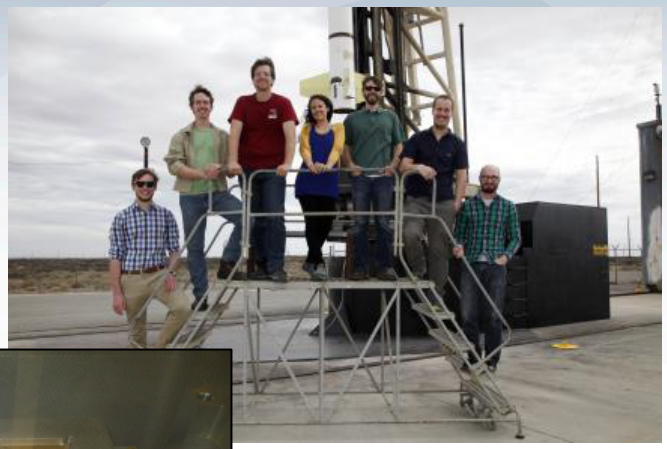
PI: K. France / Univ. of Colorado

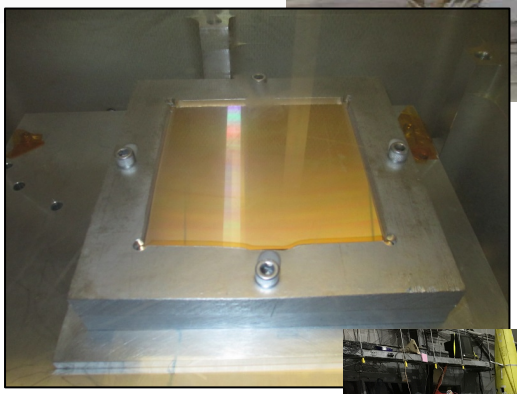
Launch: 11:10 pm MST June 26, 2017, WSMR

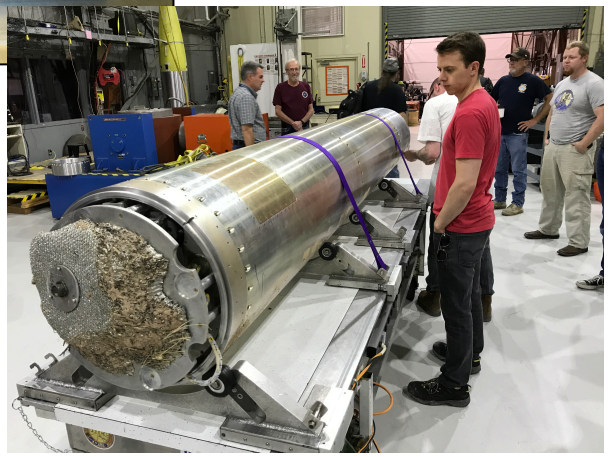
Technology: New UV gratings w/ 2x throughput of CHESS-2

Science: ISM in 'translucent clouds', at interface between primary atomic and primary molecular populations, last place in collapse sequence that is UV transparent so abundances and temperatures measurable.

Results: Over 30M photons observed on-target.







https://sites.wff.nasa.gov/code810/news/story206.html

2017 & early 2018 Sounding Rocket Launches

CHESS3 **(Flight successfully completed)**
(Colorado High-resolution Echelle Stellar Spectrograph)

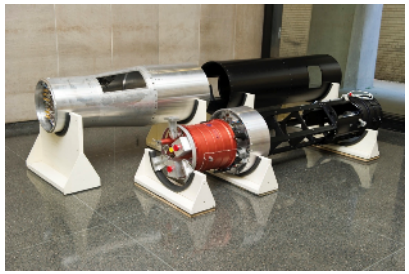
PI - **K. France** / Univ. of Colorado **Jun 26, 2017**
Technology development for future UV missions, characterizing ISM towards nearby stars.

DEUCE
(Dual-channel Extreme Ultraviolet Continuum Experiment)

PI - **J. Green** / Univ. of Colorado **Oct 2017**
Technology development for future UV missions, physics of re-ionization from B stars at extreme UV.

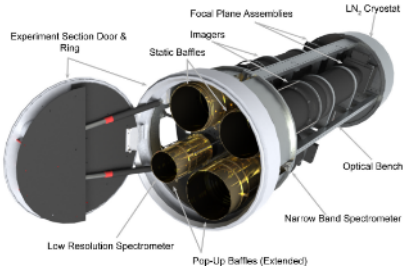
Micro-X

PI - **E. Figueroa** / Northwestern Univ. **~Feb 2018**
Characterize plasma conditions in Puppis A SNR using Transition-Edge Sensors.



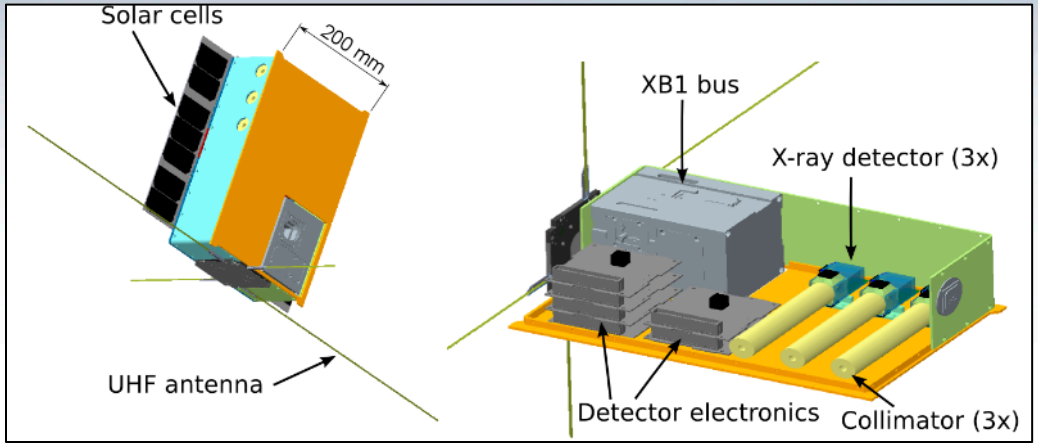
CIBER-2
(Cosmic Infrared Background Experiment)

PI - **J. Bock** / Caltech **Mar 2018**
Characterize the extragalactic near-infrared background light.



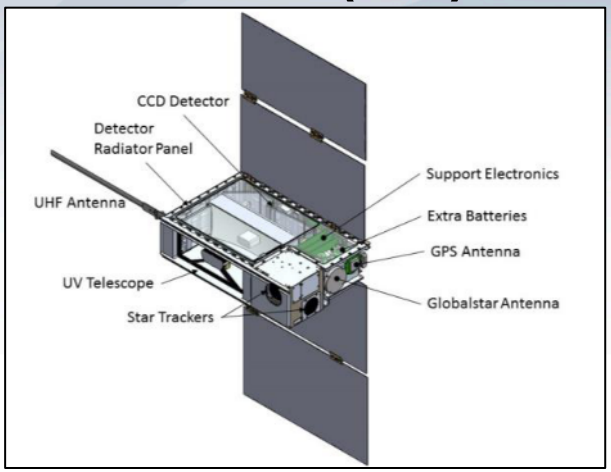
NASA Astrophysics CubeSats

HaloSat (X-ray)



- **PI**: Phil Kaaret, U Iowa
- **Co-I** at WFF, GSFC, JHU, CNRS
- **LRD**: Spring 2018, APRA-2014 selection
- **Science Objectives:** HaloSat will map the distribution of hot gas in the Milky Way and determine whether it fills an extended, and thus massive halo, or whether the halo is compact, and thus does not contribute significantly to the total mass of the Milky Way.
- **Operations**: 2 month minimum, 1 year goal

CUTE (UV)

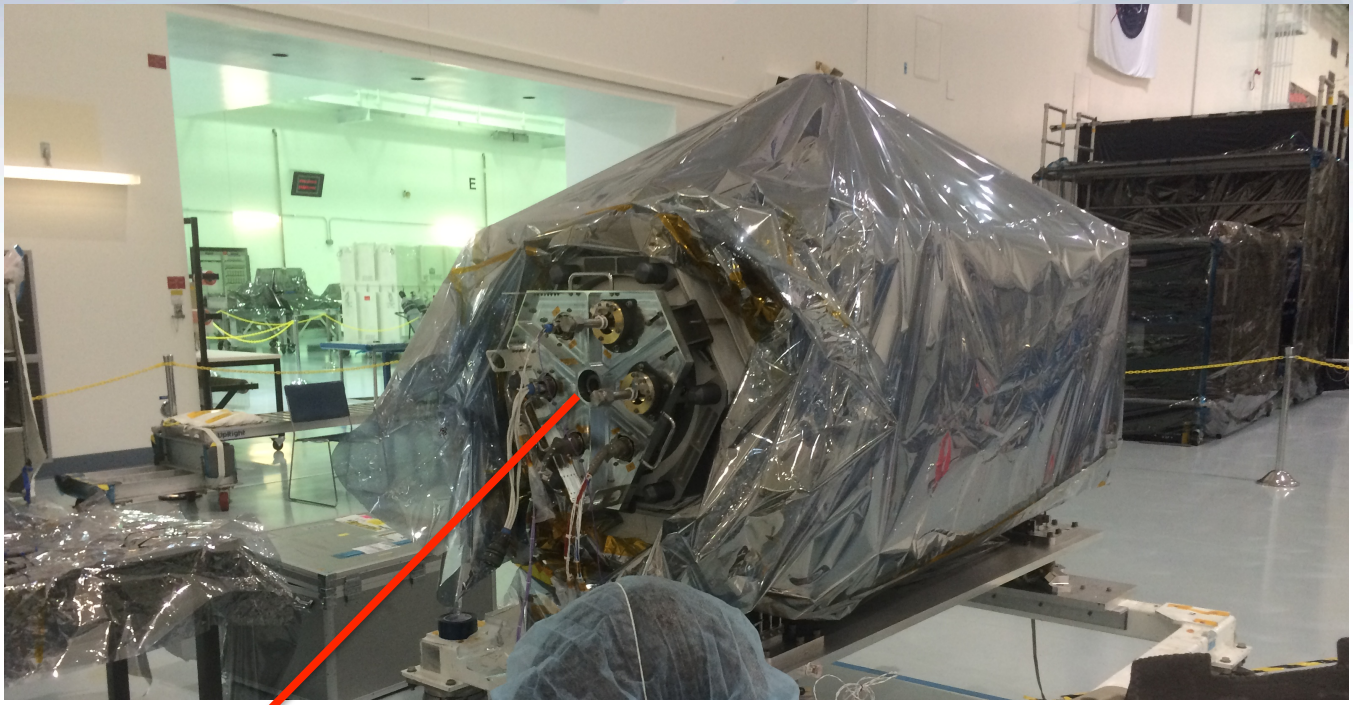


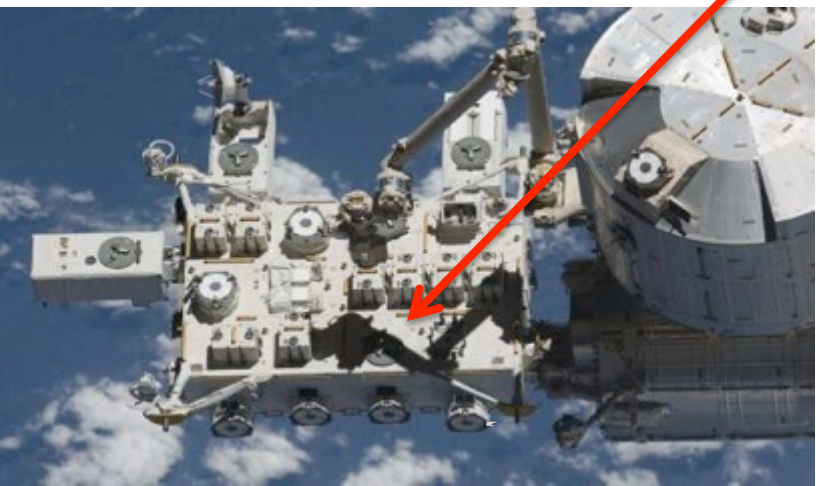
- **PI**: Kevin France, Colorado U
- **LRD**: Spring 2020, APRA-2015 selection
- **Science Objectives:** The Colorado Ultraviolet Transit Experiment (CUTE) will take multiple medium resolution UV spectra of hot Jupiters during transit, in order to measure the composition of the atmosphere being ablated away.
- **Operations**: 1 month minimum, 6 month full survey of 14 exoplanets.

CREAM

Cosmic Ray Energy and Mass

http://cosmicray.umd.edu/iss-cream/





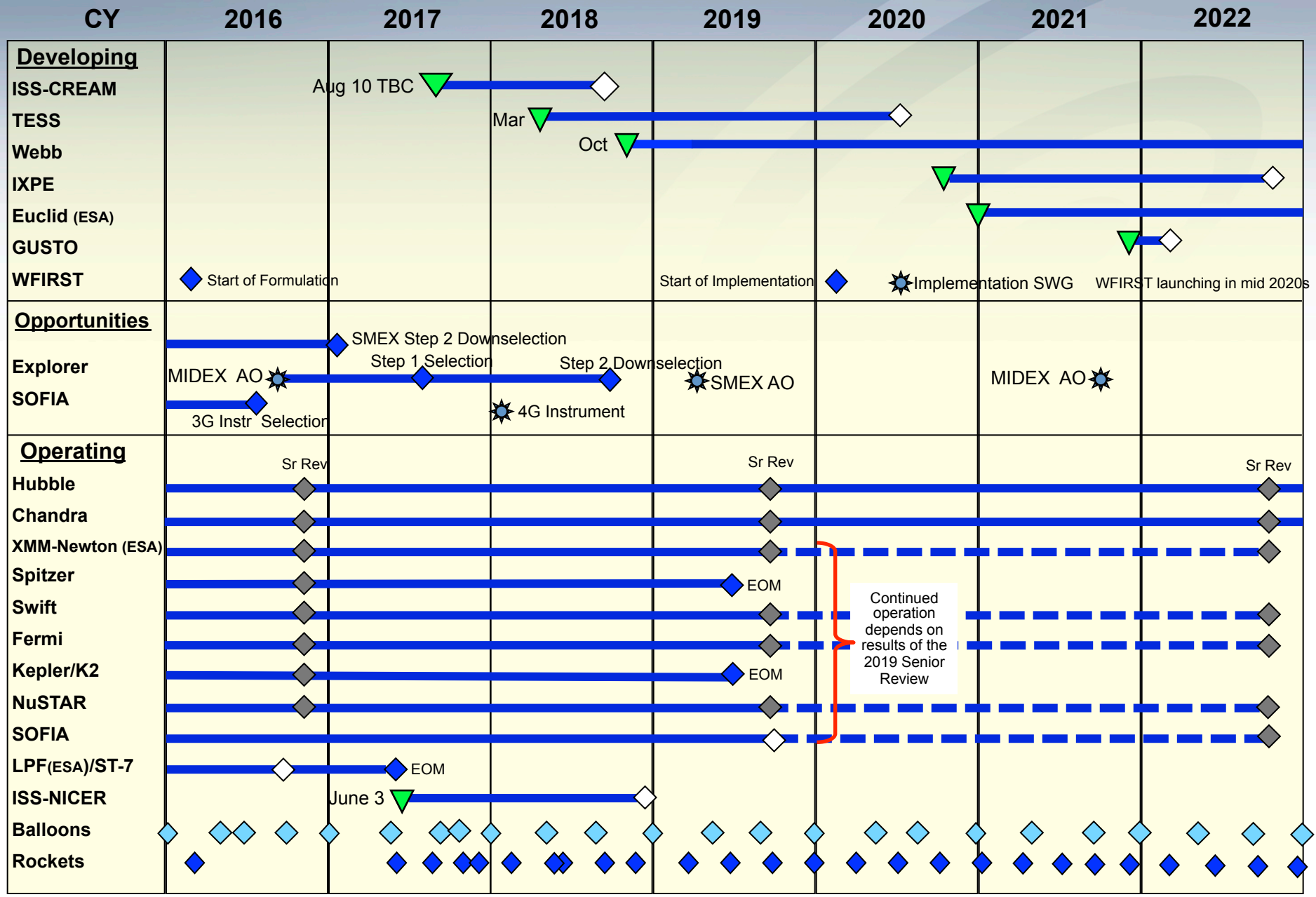
- ✓ July 2015 - CREAM delivered to KSC and stored at KSC until launch
- ✓ July 2017 - Second CDR to review the SpaceX FSE Qualification test results.
- ✓ July 17, 2017 (TBC) - Handoff to SpaceX
- • Aug 2, 2017 - KDP-E DPMP
- • Aug 10, 2017 (TBC): Launch on SpaceX-12 commercial resupply service (CRS) flight to ISS

NASA Astrophysics

Selected Mission Updates

Astrophysics Science Mission Events

Last updated: July 17, 2017



Launch Date (mission 'working to' date) **Event Date** **End of Prime Mission** **Balloon Campaigns** **AO Release** (future is notional)

Current and Future Explorer AOs

- NASA is maintaining a cadence of 4 AOs per decade, as recommended by Decadal Survey and validated by Midterm Assessment.
  - Midterm Assessment Recommendation 4-3: “NASA’s Astrophysics Division should execute its current plan, as presented to the committee, of at least four Explorer Announcements of Opportunity during the 2012-2021 decade, each with a Mission of Opportunity call, and each followed by mission selection.”
- Most recent Explorers Program AO, released in September 2016, was for a MIDEX and Mission of Opportunity (MO).
  - Proposals received in December 2016
  - Selection for 9-month competitive Phase A studies: Summer 2017 (target)
  - Down-selection: Early 2019 (target)
  - MIDEX launch readiness date no later than December 2023
  - MO launch readiness date no later than December 2022, except for Partner MOs whose launch date is set by the host mission.
- Next Explorers Program AO will be for a SMEX and MO targeted for release in early 2019.
- Subsequent Explorers Program AO is for a MIDEX and MO targeted for release in late summer 2021.

SOFIA

https://www.sofia.usra.edu/

- SOFIA arrived in Christchurch New Zealand on June 22, 2017.

  - Will use three instruments to investigate the southern skies during its 25 observation flights from June 26 - Aug 10.
  - First flight, with upGREAT instrument, was completed June 25, 2017.
- MU69 occultation in support of New Horizons on July 10, 2017.
- Instrument status:
  - 535 observing hours awarded for Cycle 5 which started in February 2017.
  - Commissioned new Upgraded German REceiver for Astronomy at Terahertz (upGREAT) High Frequency Array (HFA) in October 2016.
  - High-resolution Airborne Wideband Camera-plus (HAWC+) commissioning completed in December 2016.
  - High Resolution Mid Infrared Spectrometer (HIRMES) instrument under development.
  - Next Gen instrument solicitation planned

Astrophysics Missions in Development

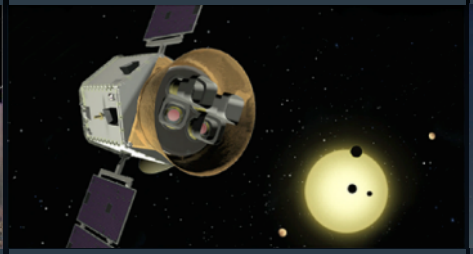
ISS-NICER — 6/3/2017
NASA Mission

Neutron Star Interior Composition Explorer

ISS-CREAM — 8/2017
NASA Mission

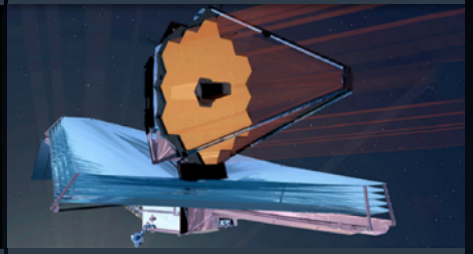
Cosmic Ray Energetics And Mass

TESS — 3/2018
NASA Mission



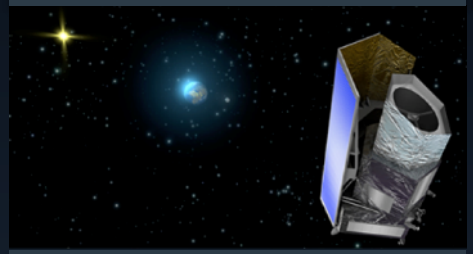
Transiting Exoplanet Survey Satellite

Webb — 10/2018
NASA Mission



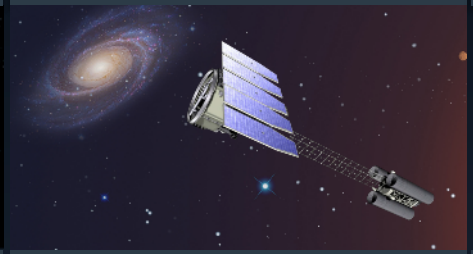
James Webb Space Telescope

Euclid — 2020
ESA-led Mission



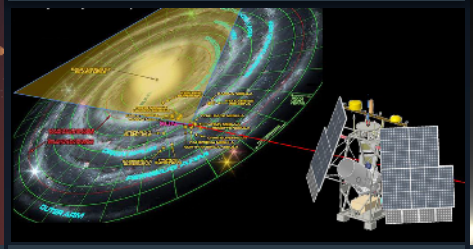
NASA is supplying the NISP Sensor Chip System (SCS)

IXPE — 2020
NASA Mission



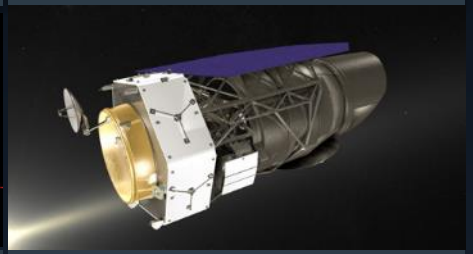
Imaging X-ray Polarimetry Explorer

GUSTO — 2021
NASA Mission



Galactic/ Extragalactic ULDB Spectroscopic Terahertz Observatory

WFIRST — Mid 2020s
NASA Mission

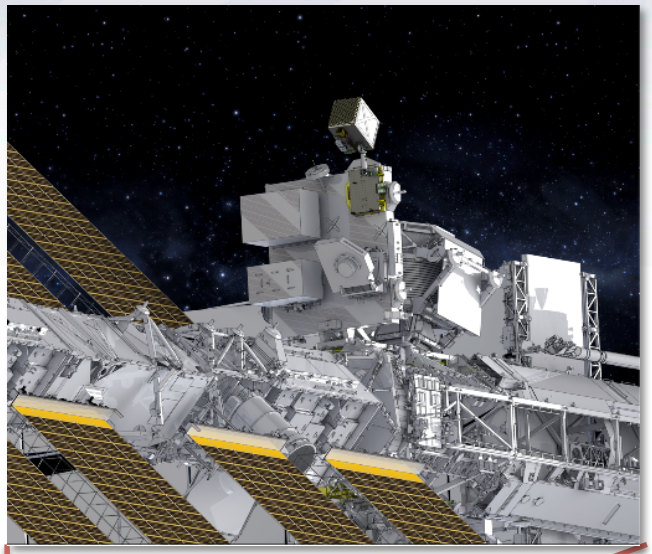


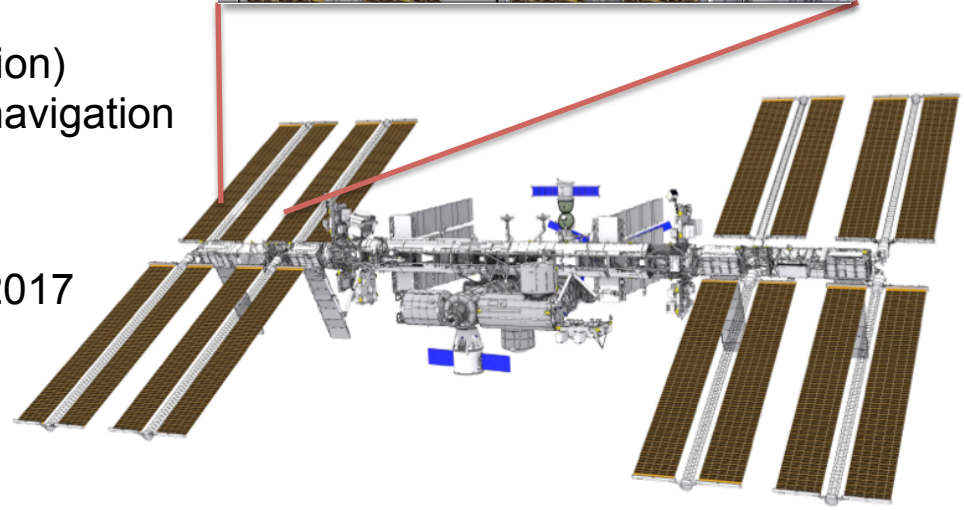
Wide-Field Infrared Survey Telescope

Neutron star Interior Composition Explorer (NICER)

Update by Keith Gendreau
Thursday Morning

- ***Science:*** Understanding ultra-dense matter through observations of neutron stars in the soft X-ray band
- ***Launch:*** June 3, 2017, SpaceX-11 resupply
- ***Platform:*** ISS ExPRESS Logistics Carrier (ELC), with active pointing over nearly a full hemisphere
- ***Duration:*** 1 month calibration + 18 months prime mission + TBD extended mission (Senior Review)
- ***Instrument:*** X-ray (0.2–12 keV) "concentrator" optics and silicon-drift detectors. GPS position & absolute time reference
- ***Enhancements:***
  - Guest Observer program (in extended mission)
  - Demonstration of pulsar-based spacecraft navigation
- ***Status:***
  - Delivered payload to KSC June 2016
  - Payload integrated into Dragon trunk April 2017
  - Launched from KSC June 3, 2017
  - Arrived at ISS June 5, 2017
  - Instrument checkout June 2017
  - Start science July 2017

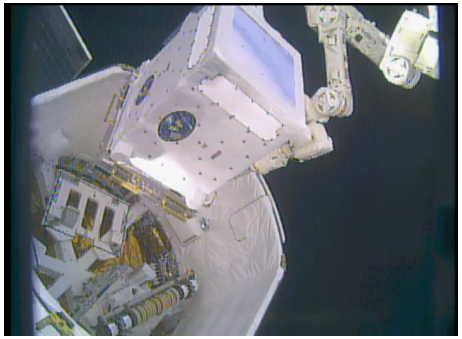


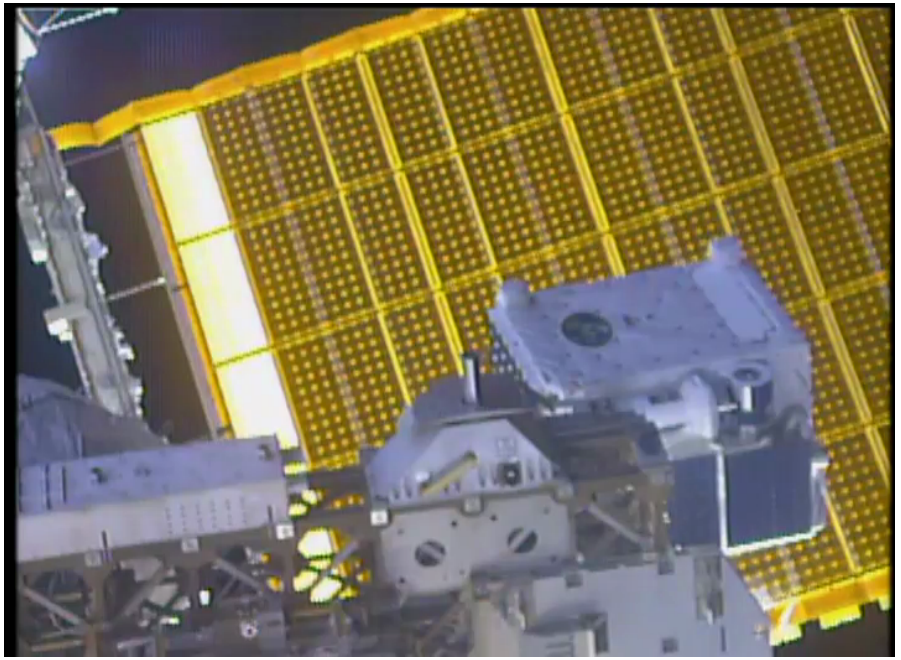


https://heasarc.gsfc.nasa.gov/docs/nicer/

NICER Launch: June 3, 2017

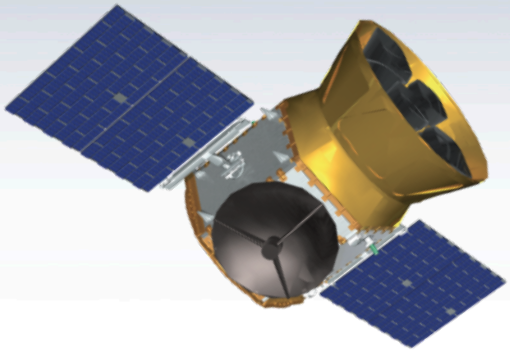
- ✓ Launch June 3, 2017
- ✓ ISS Arrival June 5, 2017
- ✓ Deploy June 11, 2017
- ✓ Checkout June 2017
- ✓ Start science July 2017





TESS

Transiting Exoplanet Survey Satellite



CURRENT STATUS:

- Both instrument and spacecraft bus completion are planned for mid July 2017.
- Observatory integration beginning in mid-Summer 2017 with completion by the end of fall 2017.
- All four flight cameras are assembled, tested, and installed on the flight camera plate.

Update by George Ricker
Wednesday Afternoon

SCHEDULE:

- July 2017 – SIR
- August 2017 – KDP-D
- January 2018 – Delivery to KSC payload processing facility
- March 2018 – Launch readiness date from Cape Canaveral FL

Medium Explorer (MIDEX) Mission

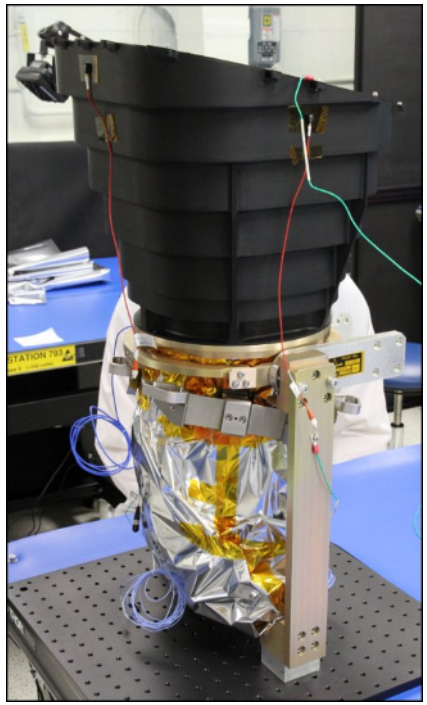
PI: G. Ricker (MIT)

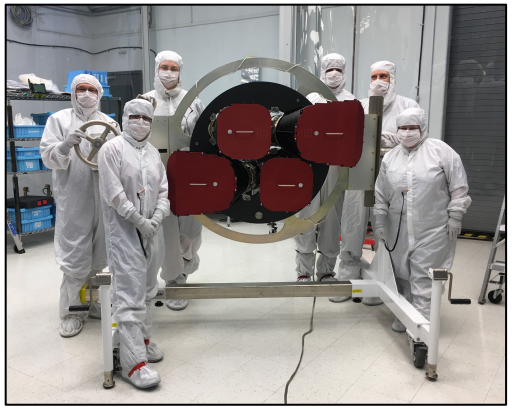
Mission: All-Sky photometric exoplanet mapping mission.

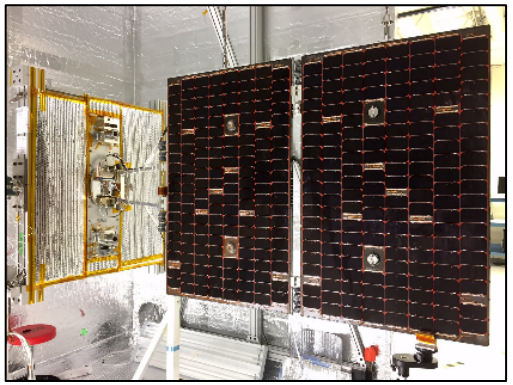
Science goal: Search for transiting exoplanets around the nearby, bright stars.

Instruments: Four wide field of view (24x24 degrees) CCD cameras with overlapping field of view, operating in the Visible-IR spectrum (0.6-1 micron).

Operations: NLT June 2018 launch with a 3-year prime mission including 2 years of spacecraft operations and an additional 1 year ground-based observations and analysis. High-Earth elliptical orbit (17 x 58.7 Earth radii).

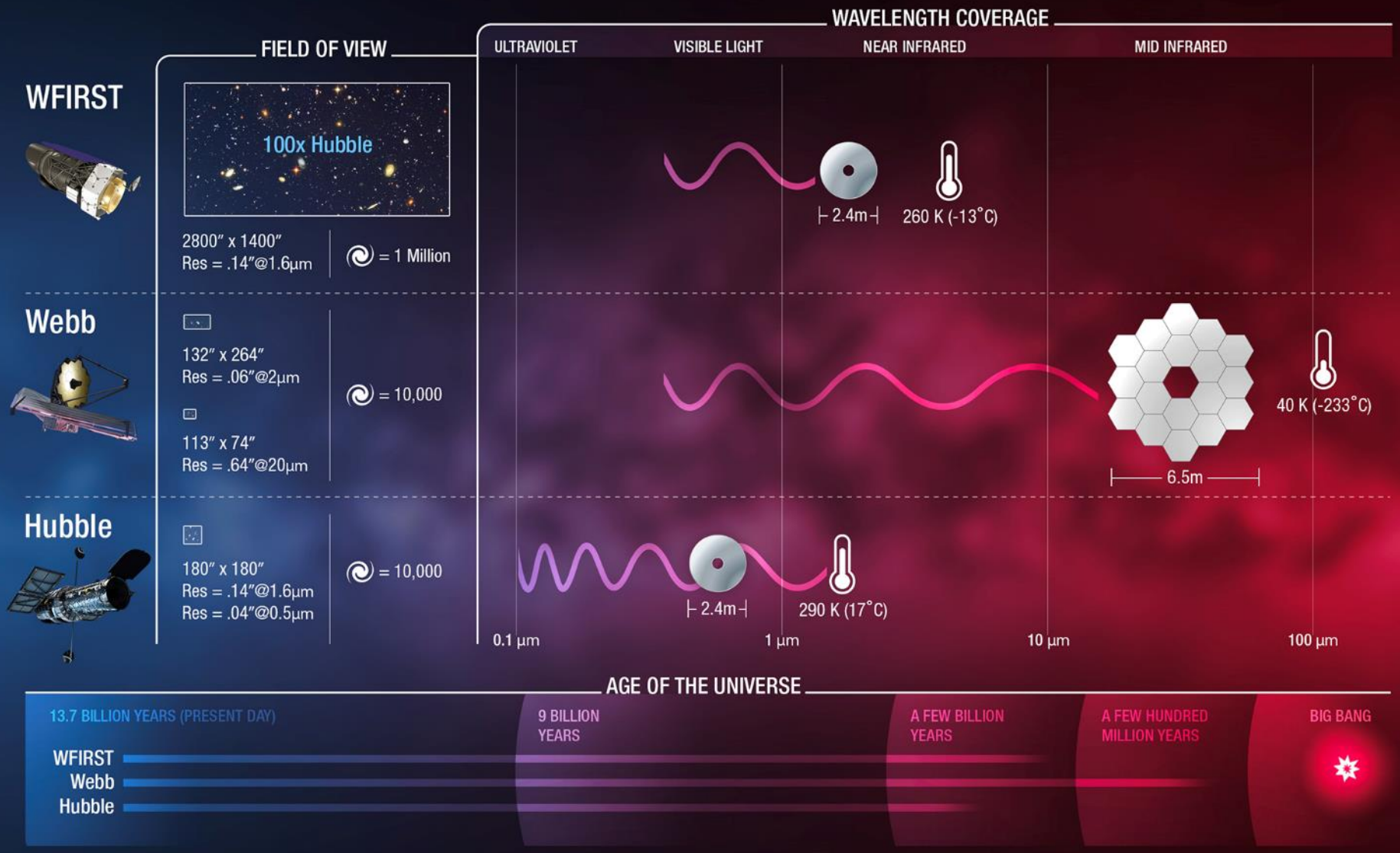




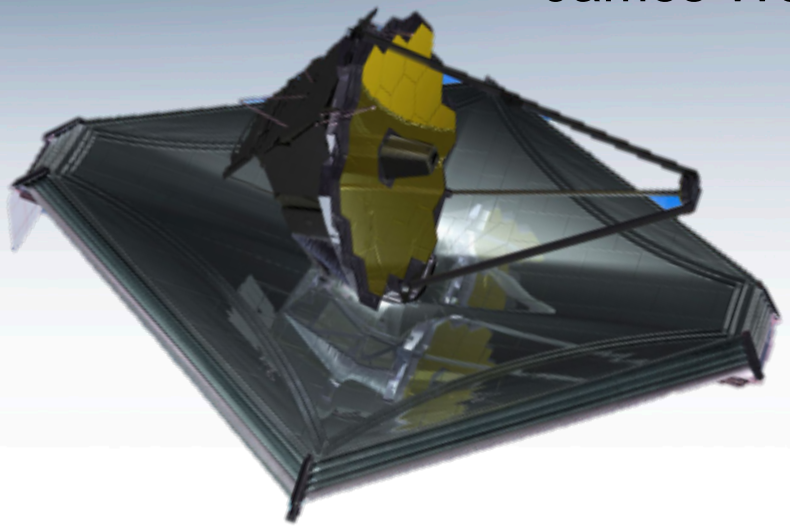


http://tess.gsfc.nasa.gov/

GREAT OBSERVATORIES



Webb
James Webb Space Telescope



Update by Eric Smith
Wednesday Afternoon

Large Infrared Space Observatory

Top priority of 2000 Decadal Survey

Science themes: First Light; Assembly of Galaxies; Birth of Stars and Planetary Systems; Planetary Systems and the Origins of Life

Mission: 6.5m deployable, segmented telescope at L2, passively cooled to <50K behind a large, deployable sunshield

Instruments: Near IR Camera, Near IR Spectrograph, Mid IR Instrument, Near IR Imager and Slitless Spectrograph

Operations: 2018 launch for a 5-year prime mission

Partners: ESA, CSA

RECENT ACCOMPLISHMENTS:

- Completed spacecraft bus assembly
- Completed ambient testing of combined telescope and instruments
- Shipped science payload to JSC for end-to-end testing
- Issued calls for Early Release Science Notices of Intent

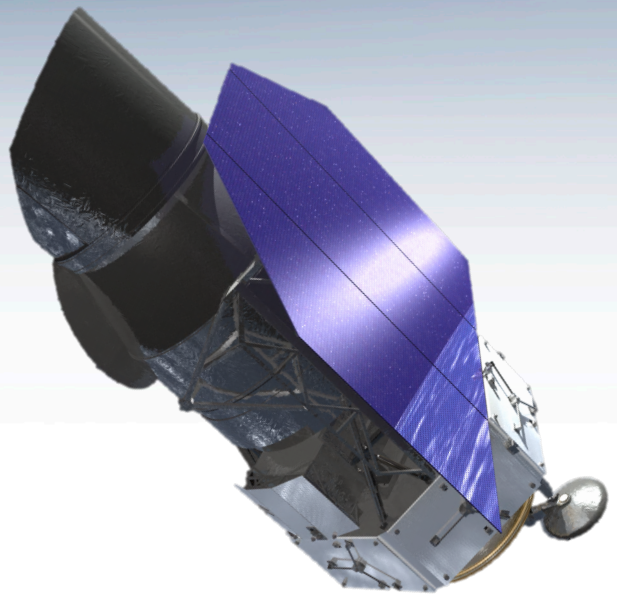
2017 Plans:

- Integrate spacecraft and sunshield
- Cryo-vacuum testing of the science payload at JSC
- Flight operations rehearsals and training

http://jwst.nasa.gov/

Webb remains on track for an October 2018 launch

WFIRST
Wide-Field Infrared Survey Telescope



Wide-Field Infrared Survey Telescope

Top priority of 2010 Decadal Survey

Science themes: Dark Energy, Exoplanets, Large Area Near Infrared Surveys

Mission: 2.4m widefield telescope at L2; using existing hardware, images 0.28deg^2 at 0.8-2μm

Instruments (design reference mission): Wide Field Instrument (camera plus IFU), Coronagraph Instrument (imaging/IFS)

Phase: Currently in Formulation (Phase A)

https://wfirst.gsfc.nasa.gov/

CURRENT STATUS:

- Successfully completed three-year technology demonstration activities on WFIRST's two critical mission technologies (near infrared detectors and coronagraph technologies)
- Completed industry formulation studies on Wide Field Instrument Optomechanical Assembly
- Conducting WFIRST Independent External Technical/Cost/Management Review (WIETR) in response to findings and recommendations in National Academies' Midterm Assessment
  - NASA is managing WFIRST with major emphasis on cost control
  - WFIRST will proceed to SRR/MDR and KDP-B after responding to WIETR recommendations
- WFIRST does not have a starshade; but NASA is studying a starshade for the next Decadal Survey's consideration.
  - Starshade compatibility is being studied during Phase A; mandated minimum impact on WFIRST.
  - NASA will decide by fall 2017 whether to maintain starshade compatibility.
- Jeff Kruk is new Project Scientist following loss of Neil Gehrels

WFIRST Independent Review

- WFIRST is the highest priority large space mission from the 2010 Decadal Survey in Astronomy and Astrophysics.
  - The 2016 Astrophysics Midterm Assessment recognized the continued compelling science value of WFIRST.
  - After several years of mission concept studies and technology investments, NASA began formulation of WFIRST in 2016.
- Two National Academies studies have recommended that NASA conduct an independent technical/management/cost (TMC) review of WFIRST before beginning Phase B and before proceeding to the Preliminary Design review.
  - Both reports expressed concern that mission cost growth could endanger the balance of NASA's astrophysics program and the alignment of its scientific priorities with those put forward by the Decadal Survey.
  - The studies are the 2014 WFIRST/AFTA study (F. Harrison et al.) and the 2016 Astrophysics Midterm Assessment (J. Hewitt et al.).
- NASA is implementing these recommendations and establishing the WFIRST Independent External TMC Review (WIETR).
- The Review has begun.
  - The review will be complete in the Fall.
  - The WFIRST System Requirements Review (SRR) / Mission Design Review (MDR), planned for Summer 2017, and beginning of Phase B, planned for Fall 2017, will be deferred until after the WIETR so that any findings and recommendations can be incorporated into the WFIRST project plan.

WFIRST Independent Review

Selected by the co-chairs, the independent review the panel is comprised of the following notable leaders in the space science community.

Dr. Peter Michelson, Stanford University (Co-Chair, Science), Stanford, California

Mr. Orlando Figueroa, NASA – Retired (Co-Chair, Program), Washington, DC

Mr. Bob Bitten, Aerospace Corporation, El Segundo, California

Dr. Roger Brissenden, Smithsonian Astrophysical Observatory, Cambridge, Massachusetts

Dr. David Charbonneau, Harvard University, Cambridge, Massachusetts

Ms. Eileen Dukes, Systems Engineer Consultant, Pine, Colorado

Dr. Daniel Eisenstein, Harvard University, Cambridge, Massachusetts

Mr. Bill Green, Jet Propulsion Laboratory – Retired, Pasadena, California

Dr. Lynne Hillenbrand, California Institute of Technology, Pasadena, California

Dr. Anne Kinney, W. M. Keck Observatory, Waimea, Hawaii

Mr. Dave Kusnierkiewicz, Applied Physics Laboratory, Laurel, Maryland

Dr. James Lloyd, Cornell University, Ithaca, New York

Dr. Dimitri Mawet, California Institute of Technology, Pasadena, California

Mr. Mark Saunders, NASA – Retired, Hampton, Virginia

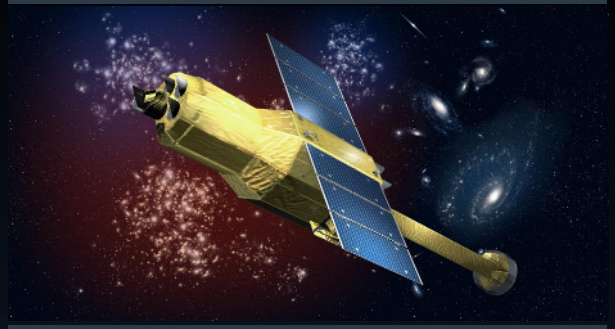
Mr. Pete Theisinger, Jet Propulsion Laboratory – Retired, Pasadena, California

Panel may be supplemented during the conduct of the review.

Astrophysics Missions under Study

XARM
2021

JAXA-led Mission



NASA is supplying the SXS Detectors, ADRs, and SXTs

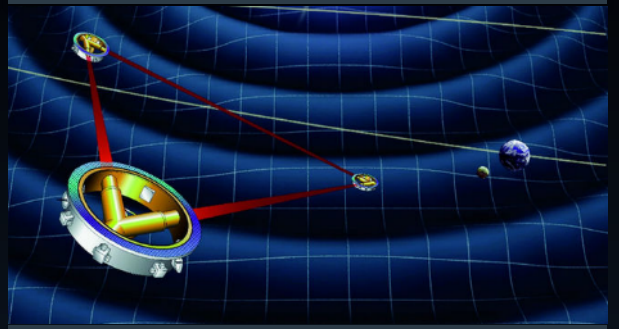
Athena
Late 2020s

ESA-led Mission

NASA is supplying elements for both instruments

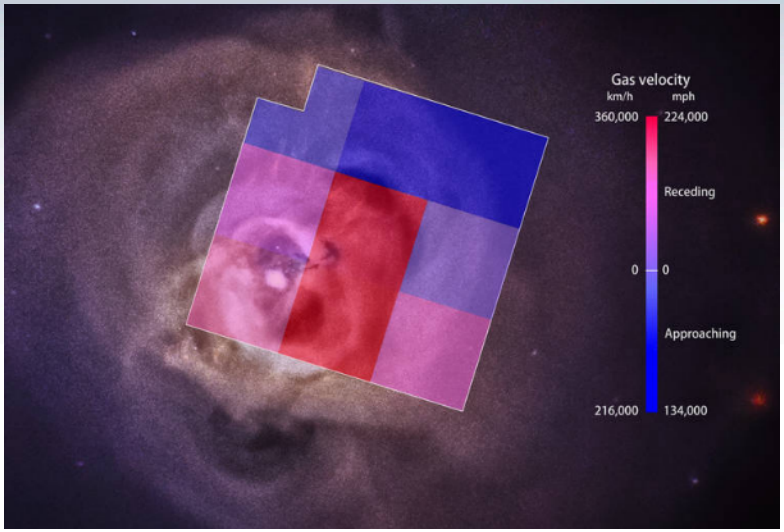
LISA
Mid 2030s

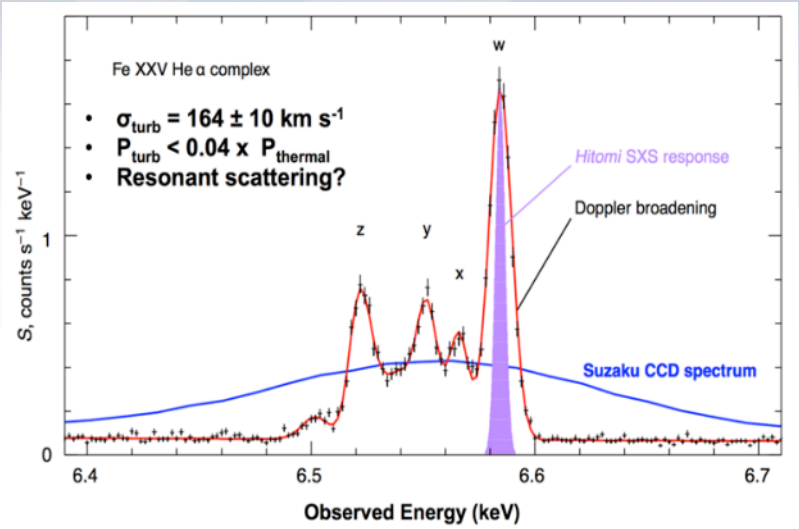
ESA-led Mission



NASA is developing technology for both the payload and the mission

X-ray Astronomy Recovery Mission





- XARM is the successor to Hitomi.
- Designed to provide breakthrough advances in our knowledge of winds, outflows, clusters, and dark matter.
- Mission will include an X-ray microcalorimeter and an X-ray imager.
- XARM approved by Japanese Diet, NASA formulation this summer.
- U.S. Community Involvement
  - The U.S. science community should expect a high level of involvement in the planning and execution of the XARM science mission.
  - NASA will openly solicit U.S. participation at an appropriate time.

X-ray Astronomy Recovery Mission

- US Community Participation in XARM
  - Participating Scientists: JAXA and NASA will each appoint a small number of Participating Scientists to the XARM Science Team; NASA will have an open solicitation in 2017. The Science Team consists of the researchers who directly contribute to the development, operation, and management of the project. As members of the XARM Science Team, Participating Scientists will have full access to Performance Verification (PV) phase data.
  - PV Phase Target Team Participation: JAXA and NASA will enable broad scientific participation in the early operation of XARM. Approximately one year before launch the Agencies will openly solicit additional community members to participate in the analysis of targets observed in the PV phase of the mission that are led by the XARM Science Team. Each PV Target Team member will become a member of an object-specific team, and will receive access to the PV data for that object.
  - General Observer Program: Following the conclusion of the PV phase of the mission approximately six to nine months after launch, XARM observing time will be dedicated to General Observations allocated through an open solicitation process.

Large Interferometer Space Antenna

SUMMARY

- The ESA SPC selected LISA as the Large 3 observatory of its Cosmic Vision Programme and has started Phase 0 (June – December 2017) with a series of technical meetings to study the payload trades.
- NASA and ESA discussions for US contributions to LISA are going well. To this end NASA is funding US-based technologies for gravitational waves with the aim of reaching TRL 5/6 by Adoption (nominally 2022).
- NASA has established a LISA Study Office at GSFC, embedded in the PCOS Program Office, charged to manage technology investments and suggest strategies for optimizing the NASA contribution to LISA.
- The LISA Study Office also serves as a liaison with the ESA LISA project. To this end, the LISA Study Office participated in a Technical Interchange Meeting with ESA at ESTEC in May 2017 and is attending regularly the ESA Phase 0 design runs.
- The NASA L3 Study team (L3ST) had its fourth face-to-face meeting on July 12 in Pasadena. The meeting was focused on finalizing the outline of the LISA report to the 2020 Decadal Survey. The report will update the LISA science case and the role of US participation in LISA.

Large Interferometer Space Antenna

Current ESA Schedule

- Phase 0: June – Dec, 2017
  - Develop requirements documents (Science, Mission, & Payload)
  - Issue Invitation to Tender for competitive Phase A by end of 2017
- Phase A: Spring 2018 - 2020
  - Competitive (two separate industrial contractors)
  - Develop detailed design and costing
  - Expect firm breakdown of responsibilities by end of Phase A
- Phase B1: 2020 - 2022
  - Continued competitive industrial studies
- Ready for Adoption by ~2022
  - Accelerated with respect to baseline Cosmic Visions schedule
  - Technologies are expected to be at TRL 5-6 by Adoption

Large Interferometer Space Antenna

Role(s) of US Science Community

- L3 Study Team
  - L3ST delivered documents (Technology Roadmap, Science Roadmaps) helping NASA define both the US contributions to ESA and the needs of the US science community to participate in LISA
  - L3ST being terminated to establish the (NASA) LISA Study Team
- LISA Study Team
  - NASA will create a US LISA Study Team as the follow-up to the L3ST
  - NASA will issue a Dear Colleague Letter to the US science community soliciting applications for the LISA ST
  - The role of the LISA ST is to:
    - Develop a compelling science case for 2020 Decadal Survey
    - Provide U.S. community with information on U.S. participation in LISA
    - Provide NASA with U.S. community input regarding the U.S. role on LISA
    - Provide communication between U.S. science community and LISA Consortium
    - Support NASA's LISA Study Office by providing analysis on scientific and technical issues, as requested
- ESA Science Study Team
  - ESA is appointing a LISA Science Study Team and has asked NASA to nominate US members
  - NASA will issue a Dear Colleague Letter to the US science community soliciting applications for the LISA Science Study Team

Preparing for the 2020 Decadal Survey

- Large Mission Concept Studies
  - Habitable Exoplanet Imaging Mission
  - Large UV/O/IR Surveyor
  - Lynx (X-ray Surveyor)
  - Origins Space Telescope (Far Infrared Surveyor)
- Astrophysics Probes / Medium Mission Concepts
  - Cosmic Dawn Intensity Mapper (A. Cooray)
  - Cosmic Evolution through UV Spectroscopy Probe (W. Danchi)
  - Galaxy Evolution Probe (J. Glenn)
  - High Spatial Resolution X-ray Probe (R. Mushotzky)
  - Inflation Probe (S. Hanany)
  - Multi-Messenger Astrophysics Probe (A. Olinto)
  - Precise Radial Velocity Observatory (P. Plavchan)
  - Starshade Rendezvous Mission (S. Seager)
  - Transient Astrophysics Probe (J. Camp)
  - X-ray Timing and Spectroscopy Probe (P. Ray)

What else should the community be studying? What else should NASA be supporting?

Decadal Survey Committee begins meeting in early 2019

Revised
July 6, 2017

NASA Astrophysics

Backup

Astrophysics Division, NASA Science Mission Directorate

Resource Management
Omana Cawthon+
Clemencia Gallegos-Kelly+
Debra Mcneill+

Director
Paul Hertz

Deputy Director
Andrea Razzaghi

Lead Secretary: Kelly Johnson
Secretary: Kyle Nero
Program Support Specialist: Jackie Mackall

Cross Cutting
Technology Lead: Billy Lightsey*
Education POC: Hashima Hasan (Lead Comm Team)
Public Affairs Lead: Kartik Sheth
Information Manager: Lisa Wainio*
Strategic Planning: Rita Sambruna

Astrophysics Research

***Program Manager*: Dan Evans**
Program Support: Ingrid Farrell*
Astrophysics Data Analysis: Doug Hudgins
Astrophysics Theory: Keith MacGregor*
Exoplanet Research: Martin Still*
APRA lead: Michael Garcia*
Cosmic Ray, Fund Physics: Thomas Hams*, Vernon Jones, Keith MacGregor*, Rita Sambruna
Gamma Ray/X-ray: Dan Evans, Michael Garcia*, Stefan Immler*, Rita Sambruna,Wilt Sanders
Optical/Ultraviolet: Michael Garcia*, Hashima Hasan, Mario Perez*, Martin Still*
IR/Submillimeter/Radio: Dominic Benford*, Doug Hudgins, Kartik Sheth, Eric Tollestrup*
Lab Astro: Doug Hudgins
Theory & Comp Astro Net: Keith MacGregor*
Roman Tech Fellows: Billy Lightsey*
Data Archives: Hashima Hasan
Astrophys Sounding Rockets: Wilt Sanders
Balloons Program: Vernon Jones(PS), Mark Sistilli (PE)

Programs / Missions & Projects

Exoplanet Exploration (EXEP)

Program	**Doug Hudgins**	**John Gagosian**
Keck	Hashima Hasan	Mario Perez*
Kepler/K2	Mario Perez*	Jeff Hayes
LBTI	Doug Hudgins	Mario Perez*
NN-EXPLORE	Doug Hudgins	Mario Perez*
WFIRST	Dominic Benford*	John Gagosian

Cosmic Origins (COR)

Program	**Mario Perez***	**Shahid Habib**
Herschel	Dominic Benford*	Jeff Hayes
Hubble	Michael Garcia*	Jeff Hayes
SOFIA	Hashima Hasan	Shahid Habib
Spitzer	Kartik Sheth*	Jeff Hayes
Webb^	Hashima Hasan	Ray Taylor^

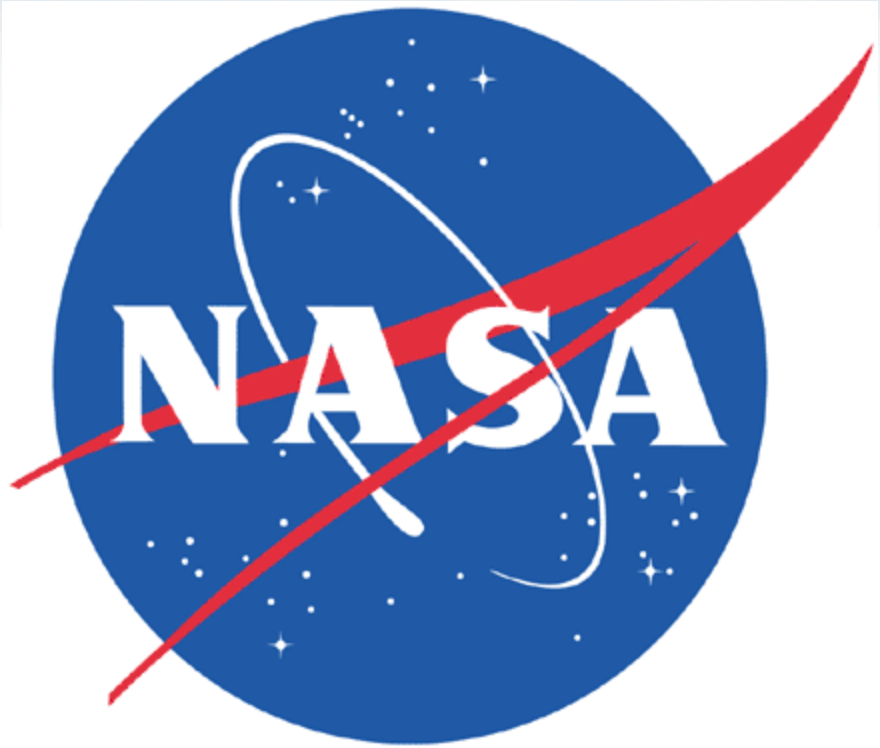
Physics of the Cosmos (PCOS)

Program	**Rita Sambruna**	**Shahid Habib**
Athena	Michael Garcia*	Jeanne Davis
Chandra	Stefan Immler*	Jeff Hayes
Euclid	Eric Tollestrup*	Shahid Habib
Fermi	Stefan Immler*	Jeff Hayes
Planck	Rita Sambruna	Jeff Hayes
ST-7/LPF	Rita Sambruna	Shahid Habib
XMM-Newton	Stefan Immler*	Jeff Hayes

Astrophysics Explorers (APEX)

Program	**Wilt Sanders**	**Jeanne Davis**
GUSTO	Thomas Hams*	TBD
IXPE	Eric Tollestrup*	Mark Sistilli
NICER	Rita Sambruna	Jeanne Davis
NuSTAR	Lou Kaluzienski	Jeff Hayes
Swift	Martin Still*	Jeff Hayes
TESS	Martin Still*	Mark Sistilli
XARM	Dan Evans	Jeanne Davis

\+ *Member of the Resources Management Division*
* *Detailee, IPA, or contractor*
^ *Webb is part of the JWST Program Office.*



Astrophysics Division
Science Mission Directorate
National Aeronautics and Space Administration